FIG. 1

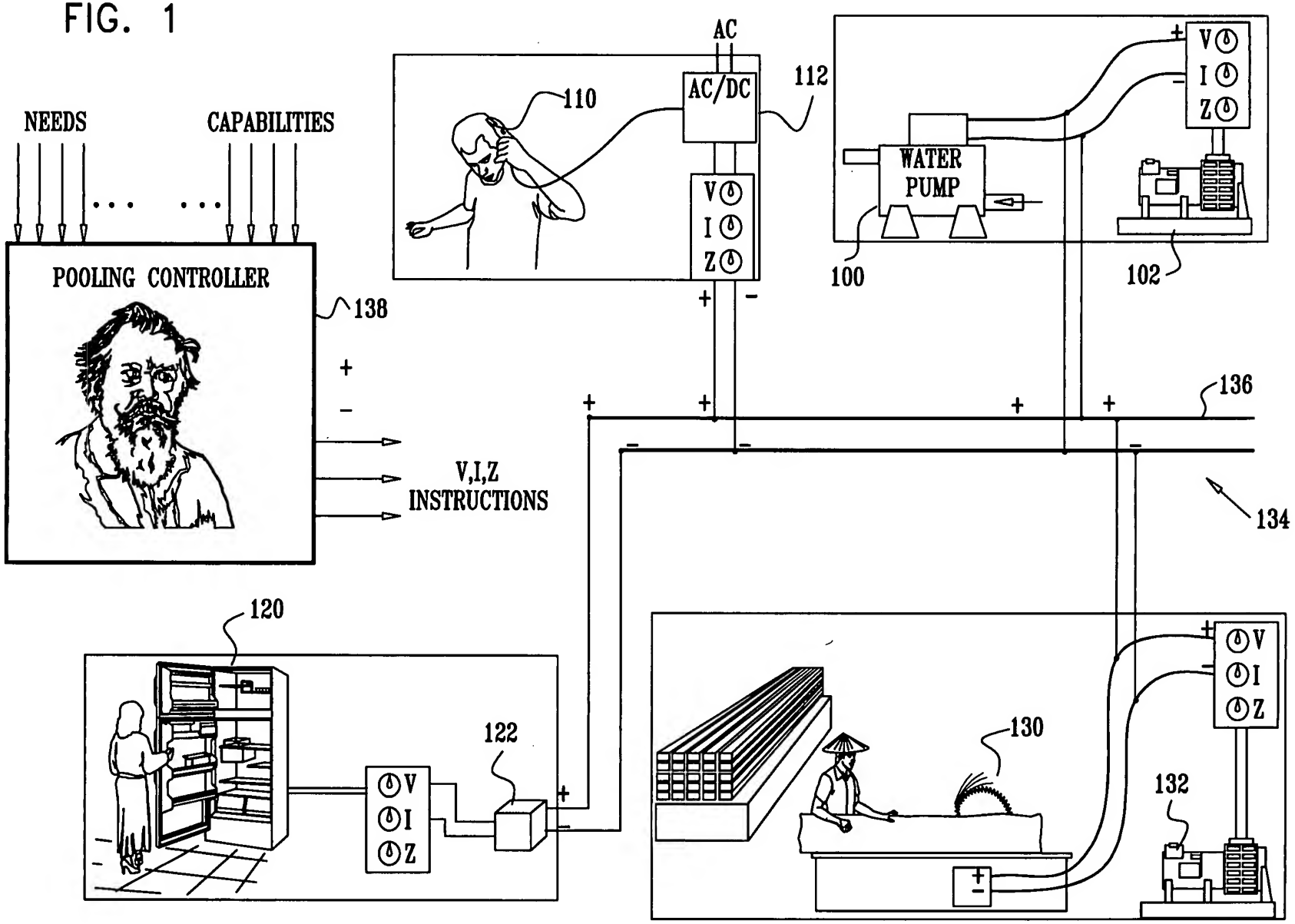

NEEDS
CAPABILITIES
POOLING CONTROLLER
138
V,I,Z
INSTRUCTIONS
AC
AC/DC
110
112
V
I
Z
WATER
PUMP
100
102
136
134
120
122
130
132

FIG. 2

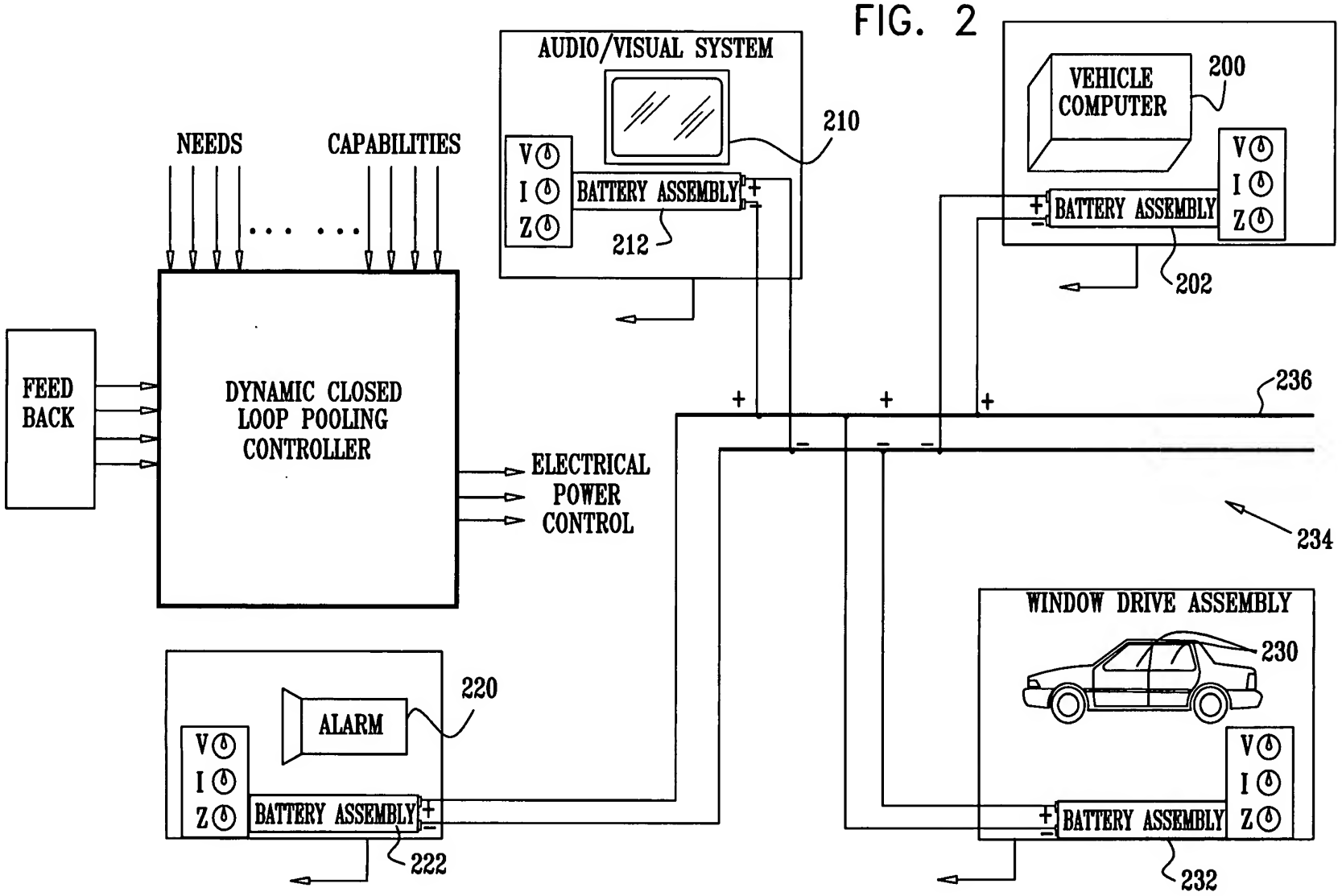

AUDIO/VISUAL SYSTEM
210
V
I
Z
BATTERY ASSEMBLY
212
VEHICLE COMPUTER
200
BATTERY ASSEMBLY
202
NEEDS
CAPABILITIES
FEED BACK
DYNAMIC CLOSED LOOP POOLING CONTROLLER
ELECTRICAL POWER CONTROL
236
234
WINDOW DRIVE ASSEMBLY
230
ALARM
220
BATTERY ASSEMBLY
222
BATTERY ASSEMBLY
232

FIG. 3

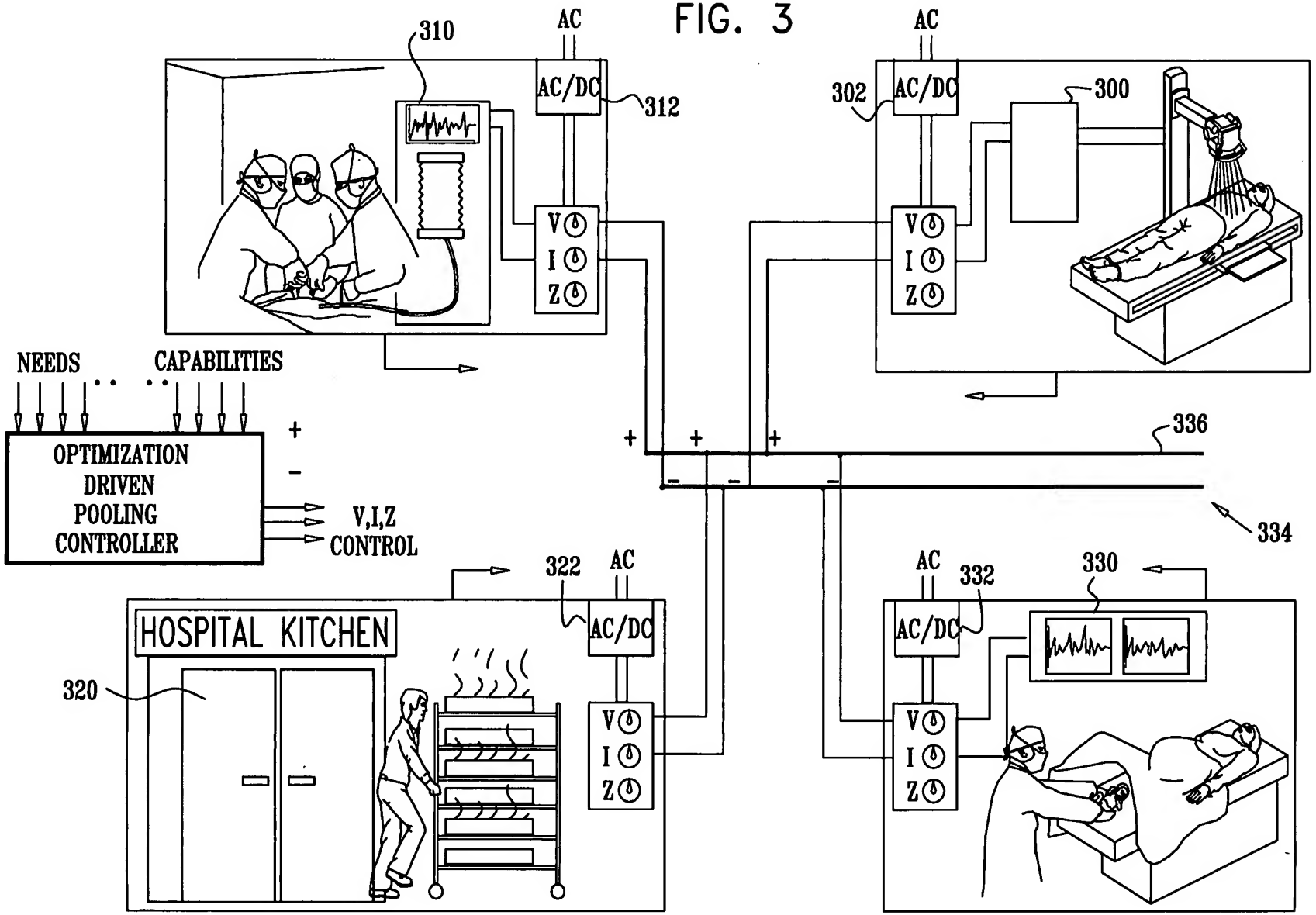

310
AC
AC/DC
312
V
I
Z
302
300
NEEDS
CAPABILITIES
OPTIMIZATION
DRIVEN
POOLING
CONTROLLER
+
-
V,I,Z
CONTROL
336
334
322
HOSPITAL KITCHEN
320
332
330

FIG. 4

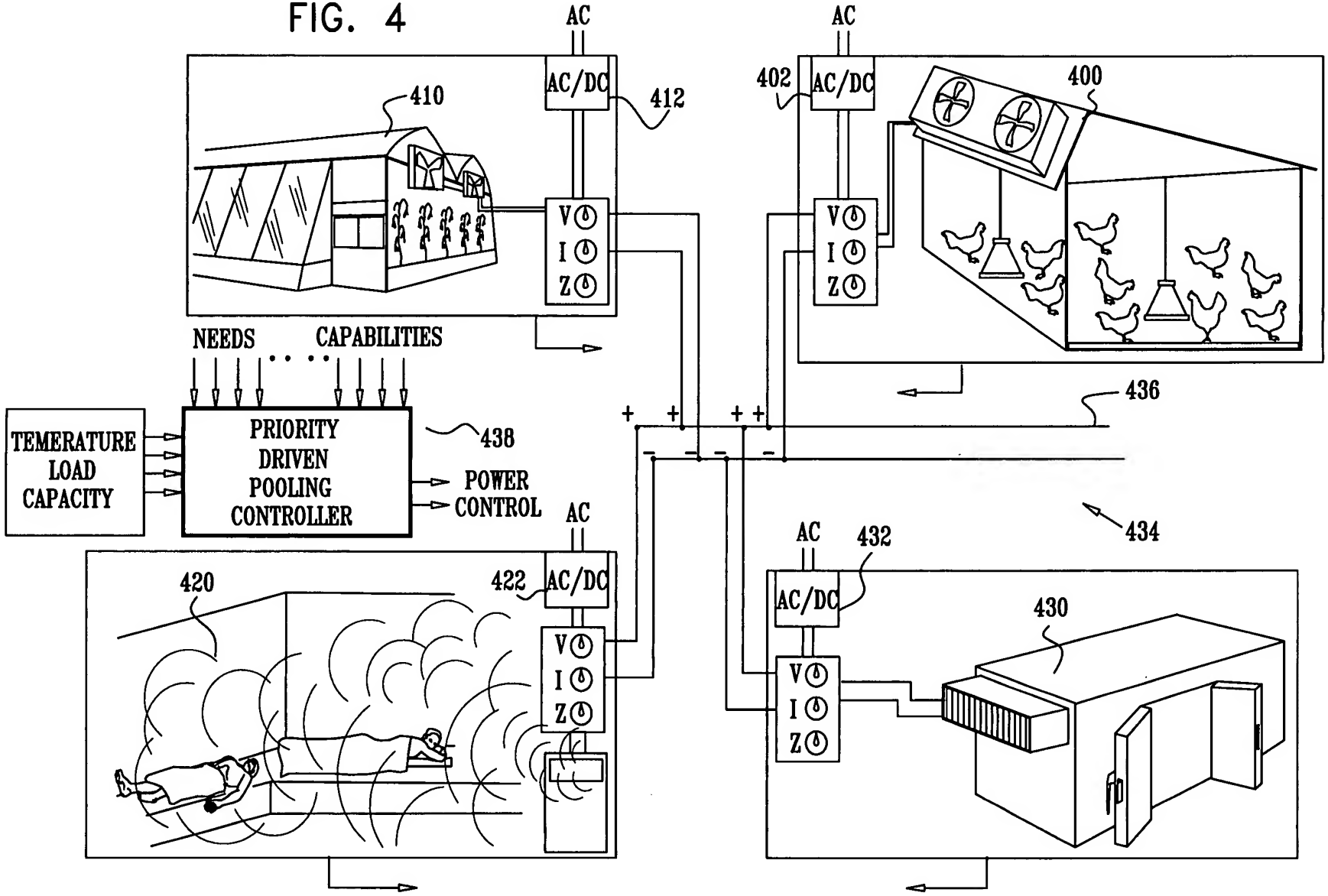

AC
AC/DC
412
410
V
I
Z
NEEDS
CAPABILITIES
TEMERATURE
LOAD
CAPACITY
PRIORITY
DRIVEN
POOLING
CONTROLLER
438
POWER
CONTROL
402
400
436
434
420
422
432
430

FIG. 5

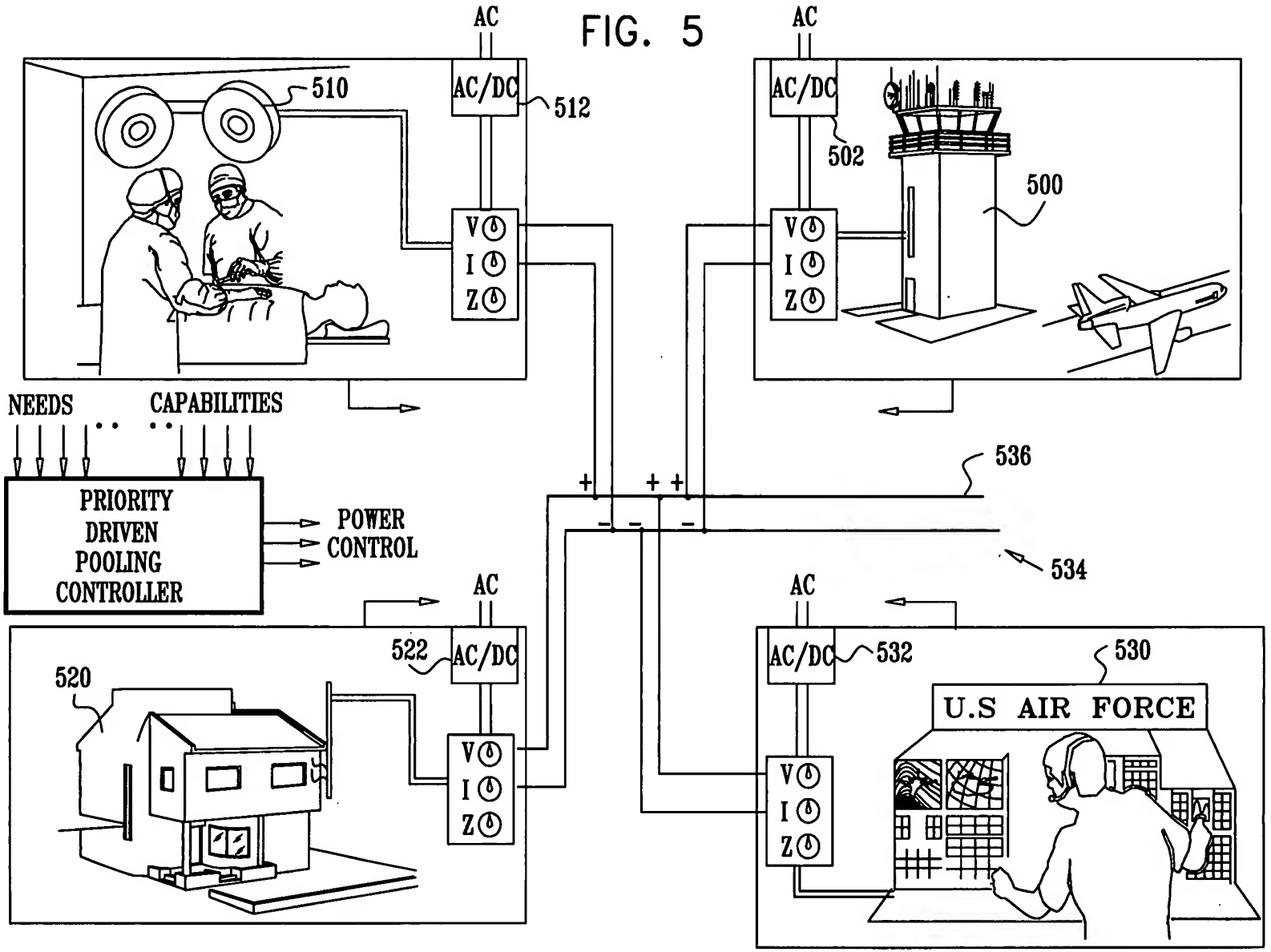

AC
AC/DC
512
510
V
I
Z
AC
AC/DC
502
500
V
I
Z
NEEDS
CAPABILITIES
PRIORITY
DRIVEN
POOLING
CONTROLLER
POWER
CONTROL
536
534
AC
AC/DC
522
520
V
I
Z
AC
AC/DC
532
530
U.S AIR FORCE
V
I
Z

FIG. 6

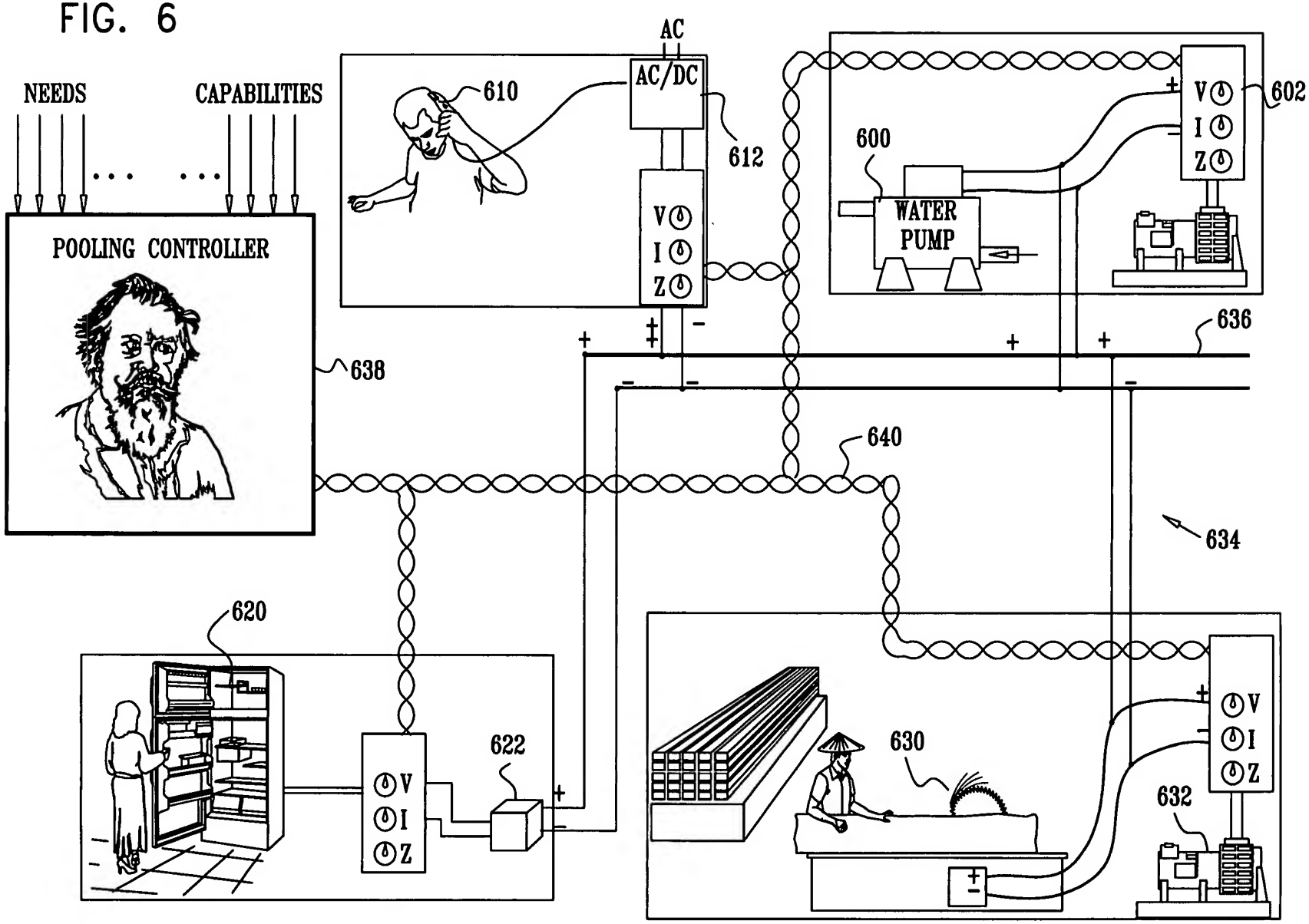

NEEDS
CAPABILITIES
POOLING CONTROLLER
638
AC
AC/DC
610
612
V
I
Z
600
WATER PUMP
602
636
640
634
620
622
630
632

FIG. 7

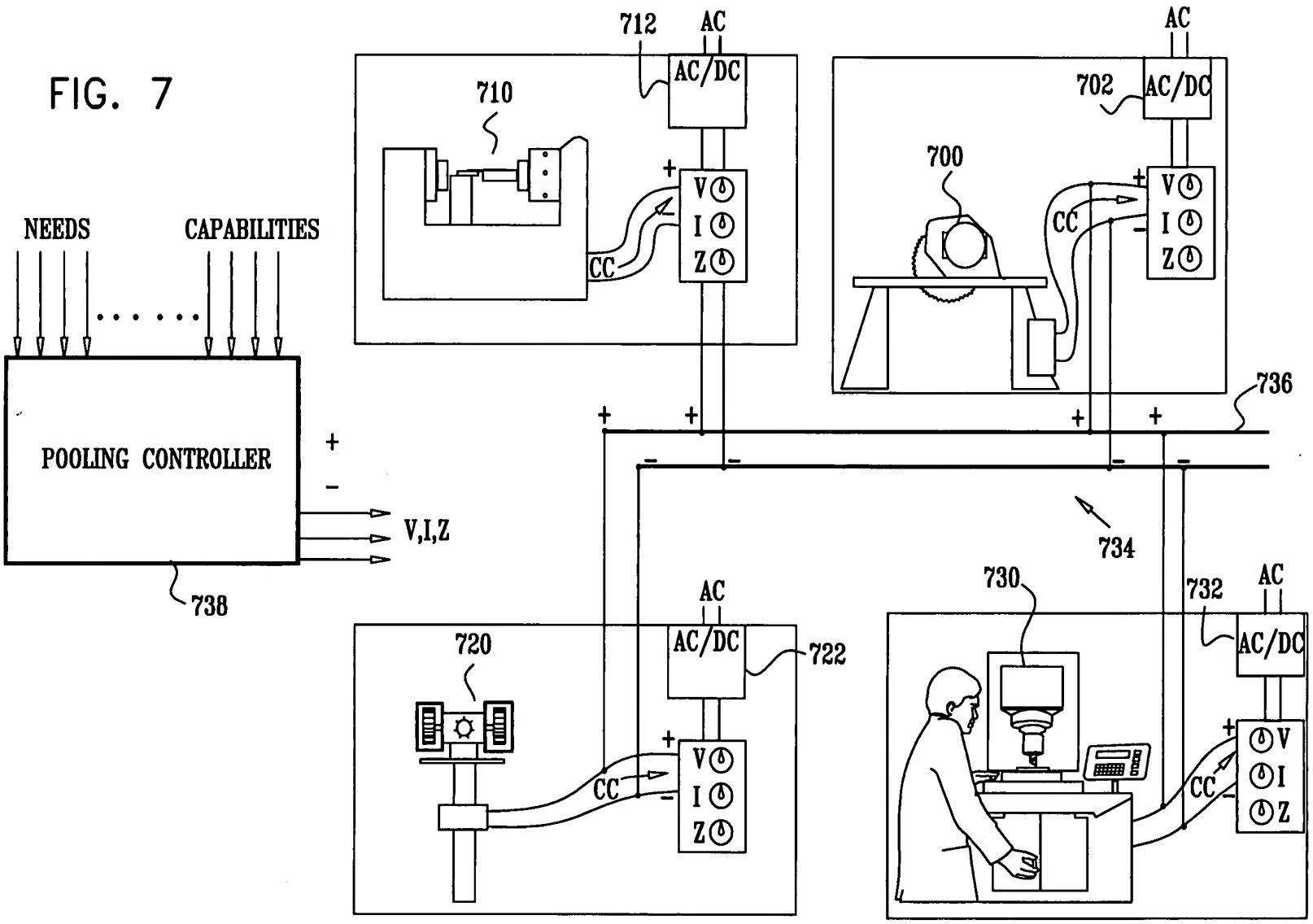

NEEDS
CAPABILITIES
POOLING CONTROLLER
738
V,I,Z
712
AC
AC/DC
710
CC
V
I
Z
702
700
736
734
720
722
730
732

FIG. 8

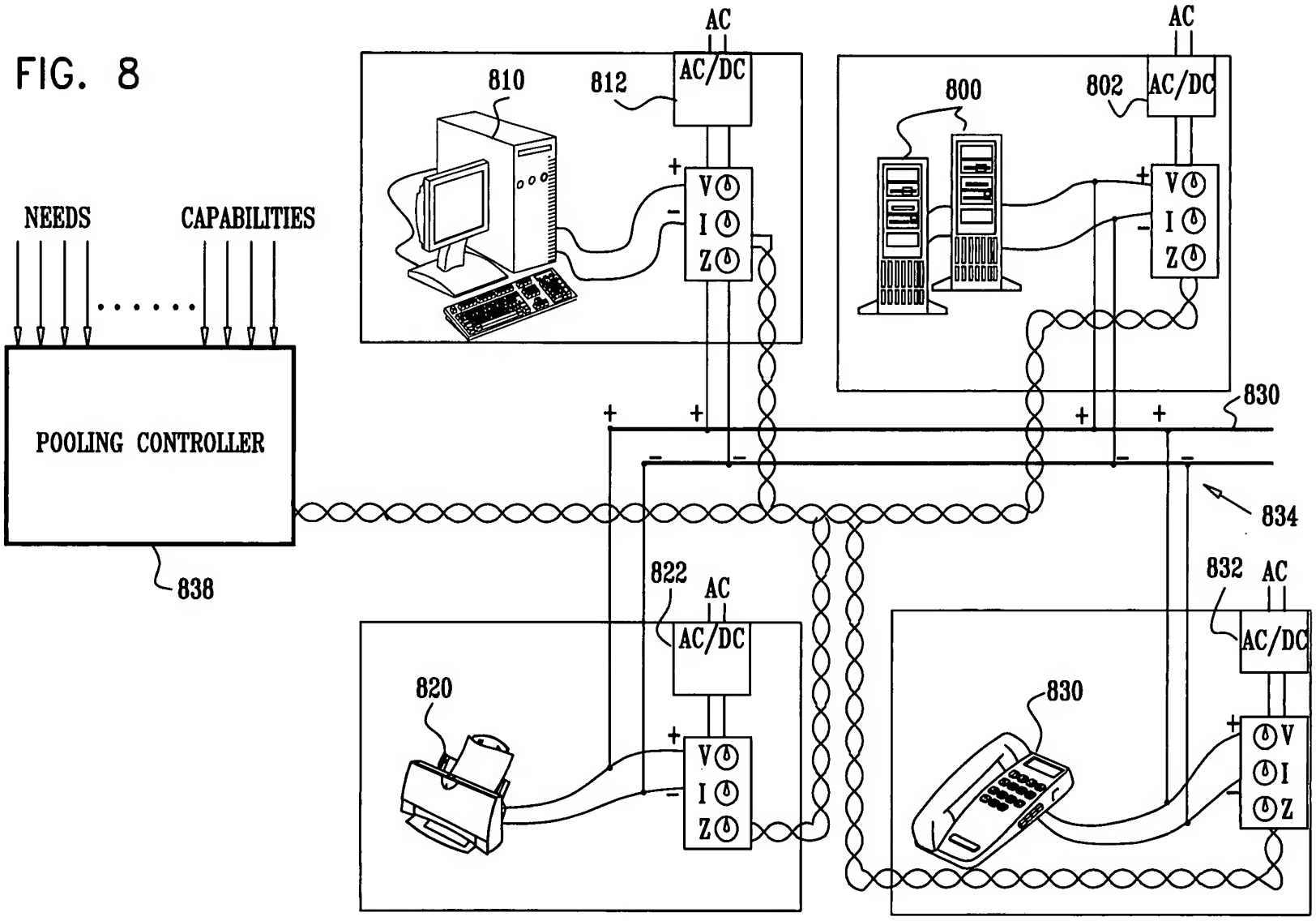

NEEDS
CAPABILITIES
POOLING CONTROLLER
838
AC
AC/DC
810
812
V
I
Z
800
802
830
834
822
820
832

FIG. 9

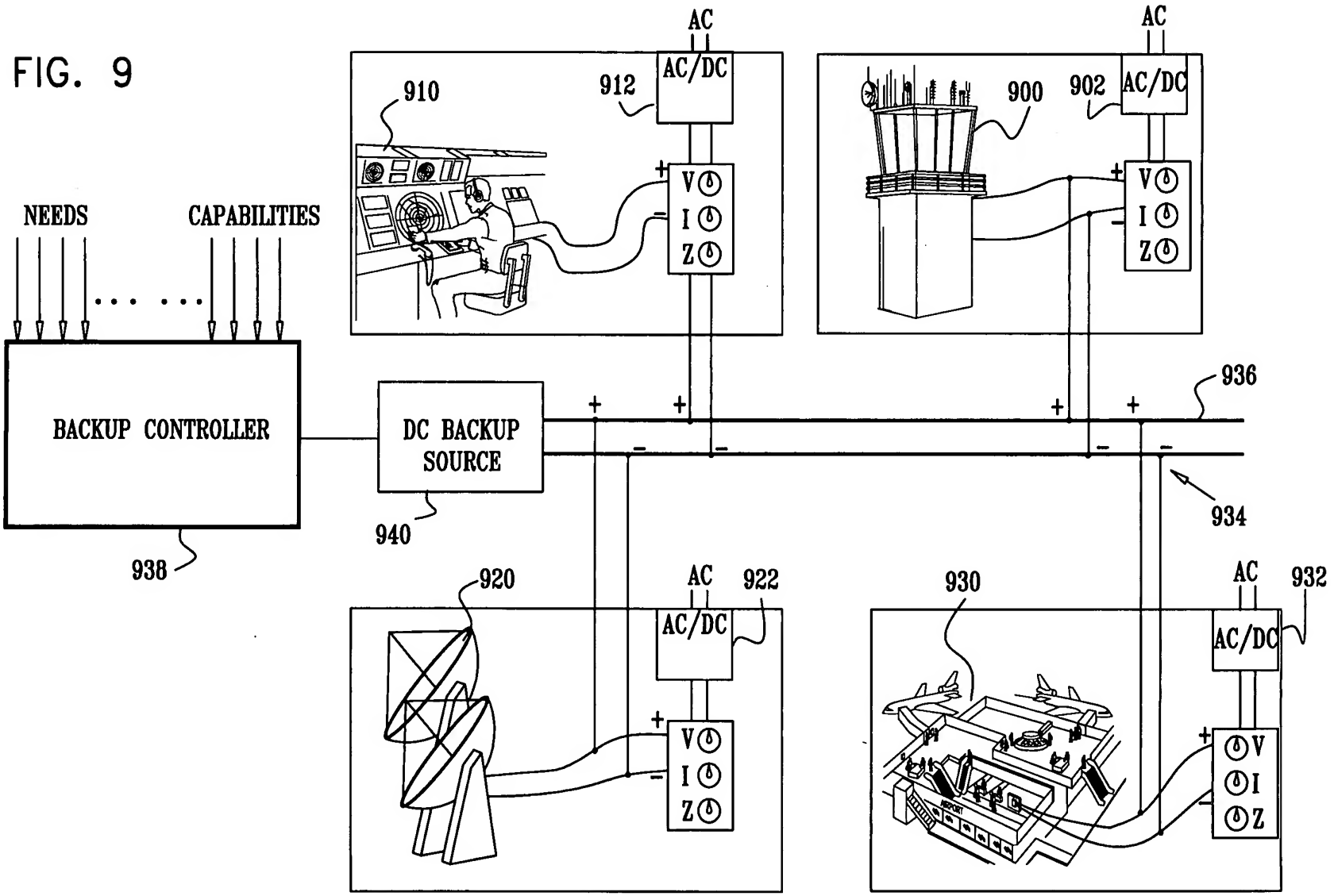
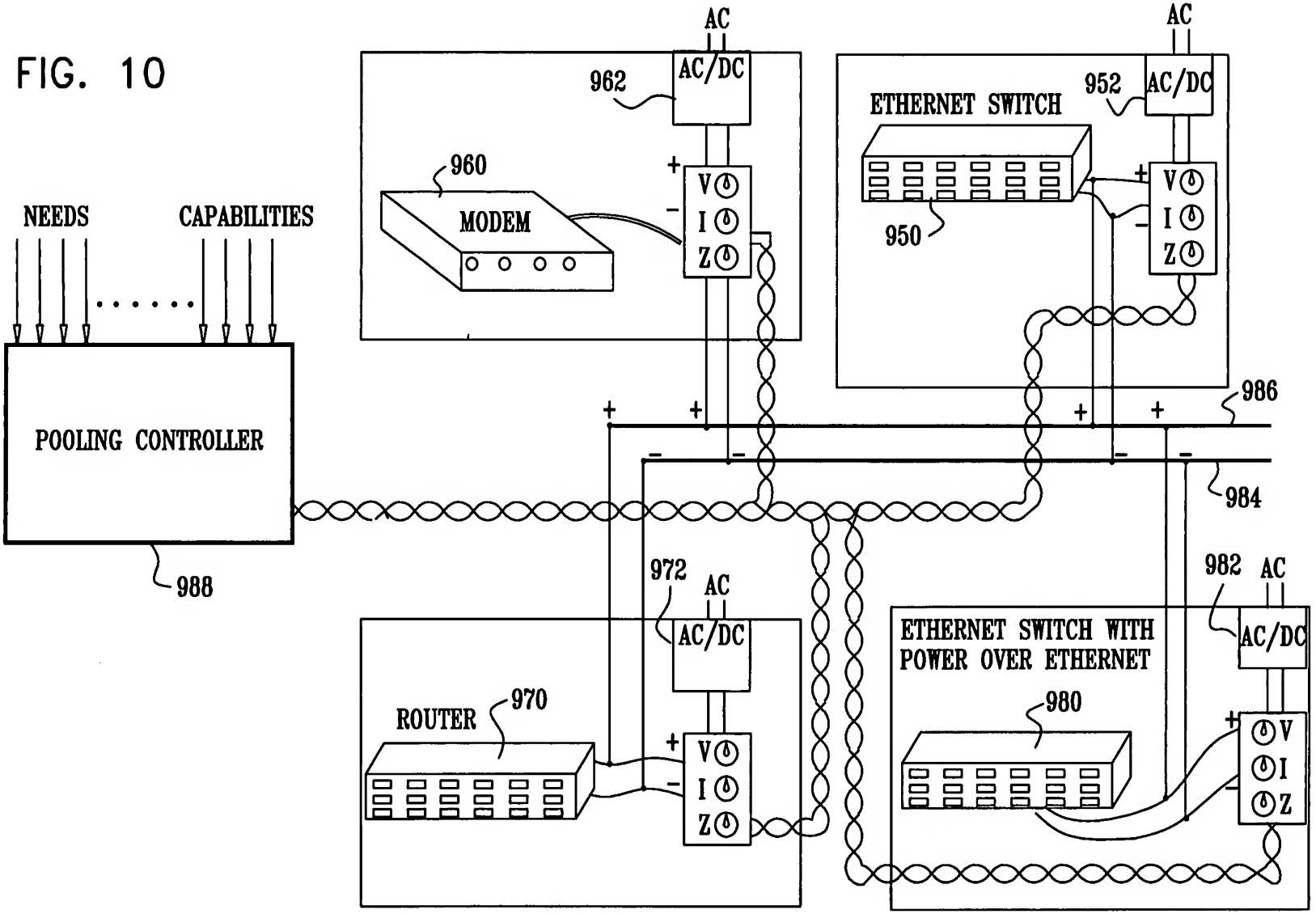

NEEDS
CAPABILITIES
BACKUP CONTROLLER
938
DC BACKUP SOURCE
940
AC
AC/DC
910
912
V
I
Z
900
902
936
934
920
922
930
932

FIG. 10


NEEDS
CAPABILITIES
POOLING CONTROLLER
988
AC
AC/DC
962
960
MODEM
V
I
Z
ETHERNET SWITCH
952
950
986
984
972
ROUTER
970
982
ETHERNET SWITCH WITH POWER OVER ETHERNET
980

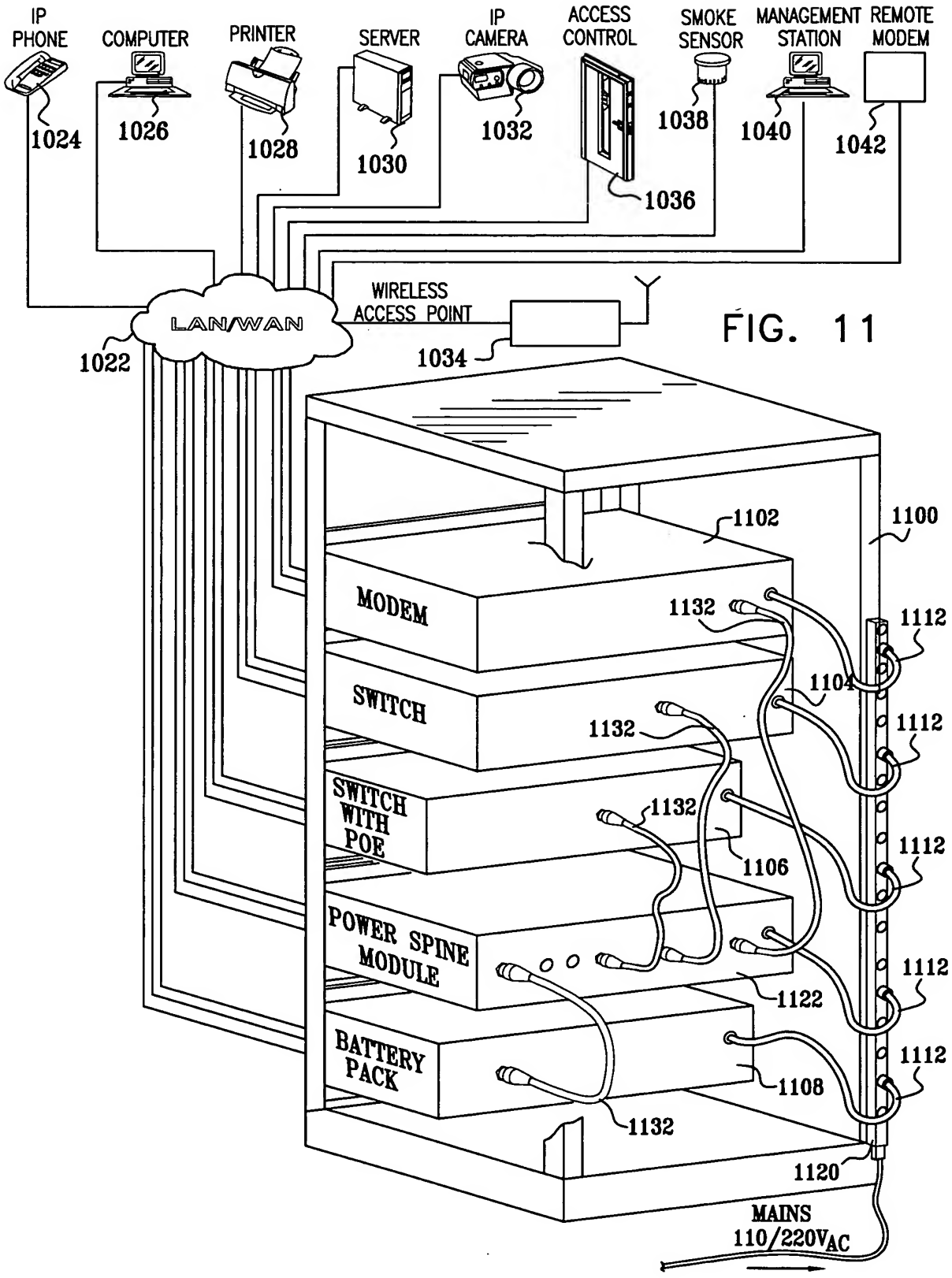

IP PHONE
COMPUTER
PRINTER
SERVER
IP CAMERA
ACCESS CONTROL
SMOKE SENSOR
MANAGEMENT STATION
REMOTE MODEM
1024
1026
1028
1030
1032
1036
1038
1040
1042
WIRELESS ACCESS POINT
LAN/WAN
1022
1034
1102
1100
MODEM
1132
1112
1104
SWITCH
1132
1112
SWITCH WITH POE
1132
1106
1112
POWER SPINE MODULE
1122
1112
BATTERY PACK
1108
1112
1132
1120
MAINS 110/220V AC

FIG. 11

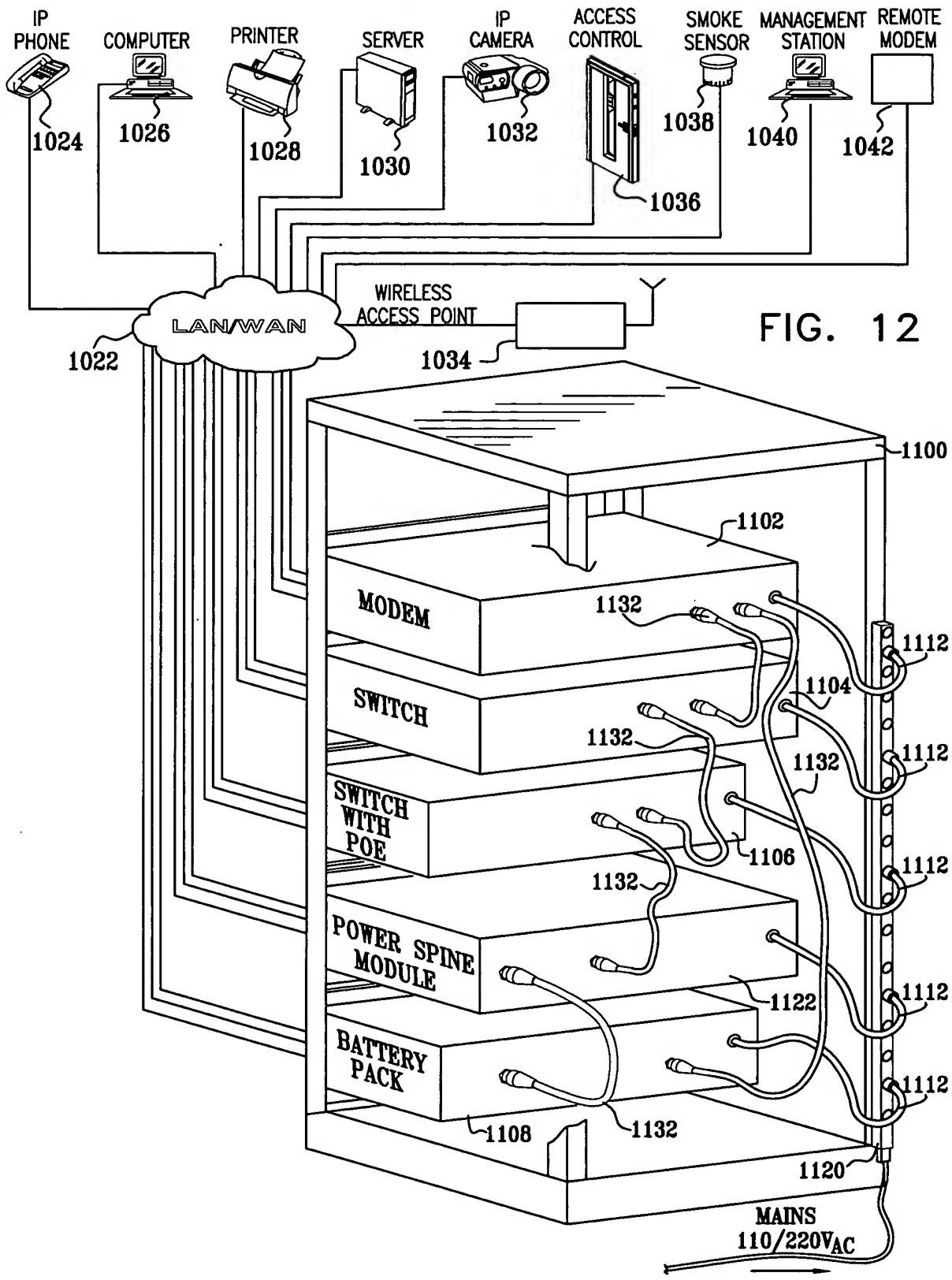

IP PHONE
COMPUTER
PRINTER
SERVER
IP CAMERA
ACCESS CONTROL
SMOKE SENSOR
MANAGEMENT STATION
REMOTE MODEM
1024
1026
1028
1030
1032
1036
1038
1040
1042
LAN/WAN
1022
WIRELESS ACCESS POINT
1034
1100
1102
MODEM
SWITCH
SWITCH WITH POE
POWER SPINE MODULE
BATTERY PACK
1132
1104
1106
1108
1112
1120
1122
MAINS 110/220V$_{AC}$

FIG. 12

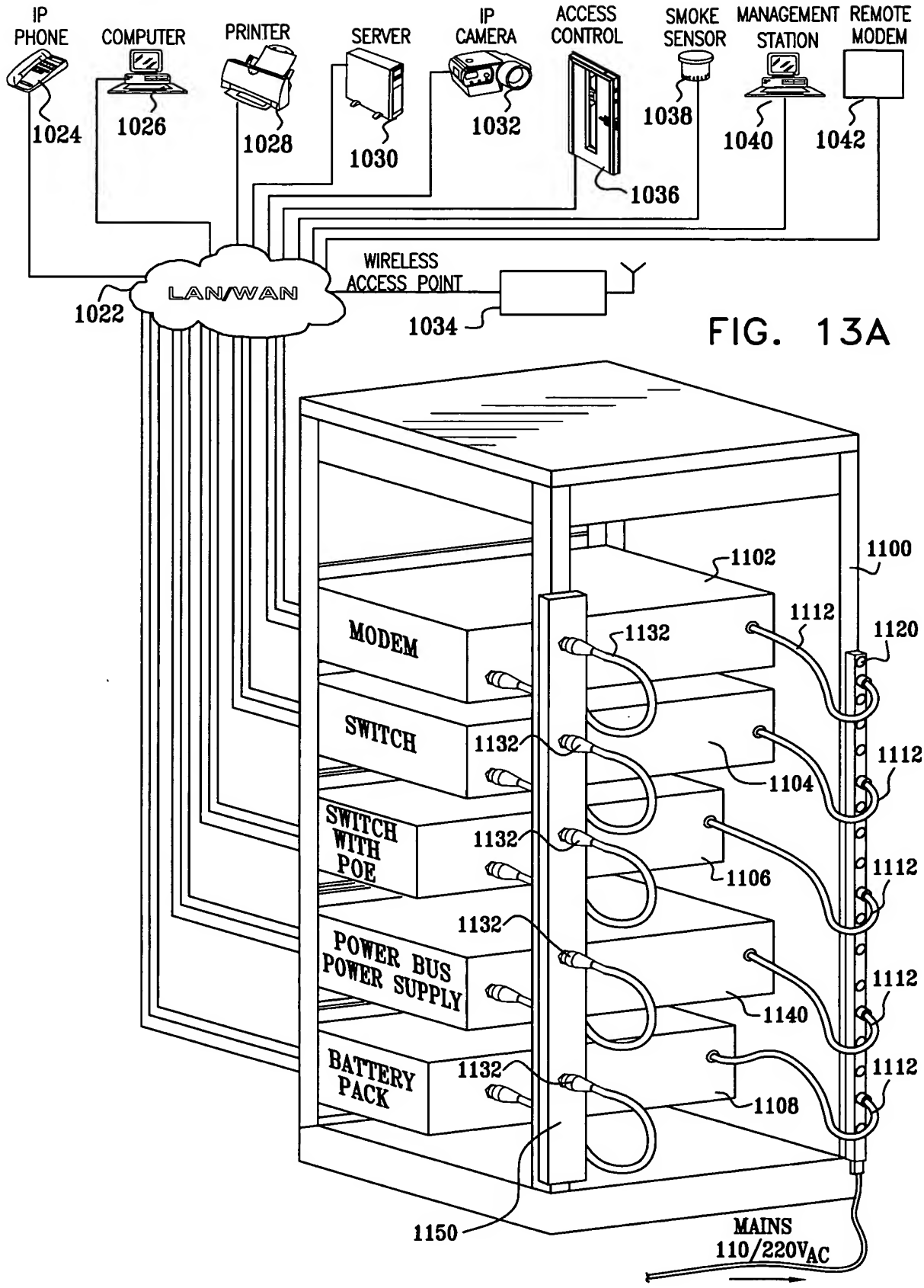

IP PHONE
COMPUTER
PRINTER
SERVER
IP CAMERA
ACCESS CONTROL
SMOKE SENSOR
MANAGEMENT STATION
REMOTE MODEM
1024
1026
1028
1030
1032
1036
1038
1040
1042
LAN/WAN
1022
WIRELESS ACCESS POINT
1034
MODEM
SWITCH
SWITCH WITH POE
POWER BUS POWER SUPPLY
BATTERY PACK
1100
1102
1104
1106
1108
1112
1120
1132
1140
1150
MAINS 110/220VAC

FIG. 13A

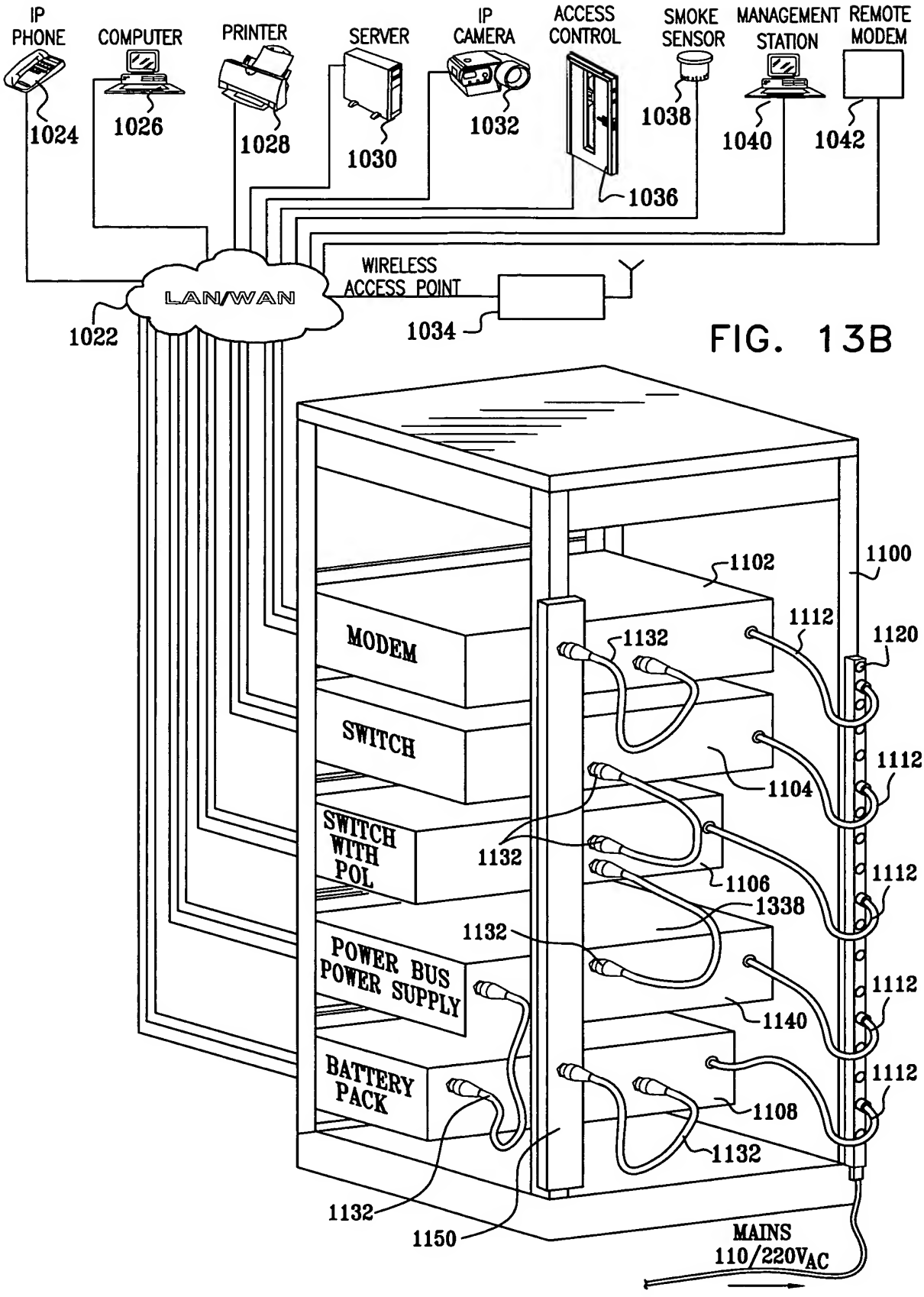

IP PHONE
COMPUTER
PRINTER
SERVER
IP CAMERA
ACCESS CONTROL
SMOKE SENSOR
MANAGEMENT STATION
REMOTE MODEM
1024
1026
1028
1030
1032
1036
1038
1040
1042
LAN/WAN
WIRELESS ACCESS POINT
1022
1034
MODEM
SWITCH
SWITCH WITH POL
POWER BUS POWER SUPPLY
BATTERY PACK
1100
1102
1104
1106
1108
1112
1120
1132
1140
1150
1338
MAINS 110/220VAC

FIG. 13B

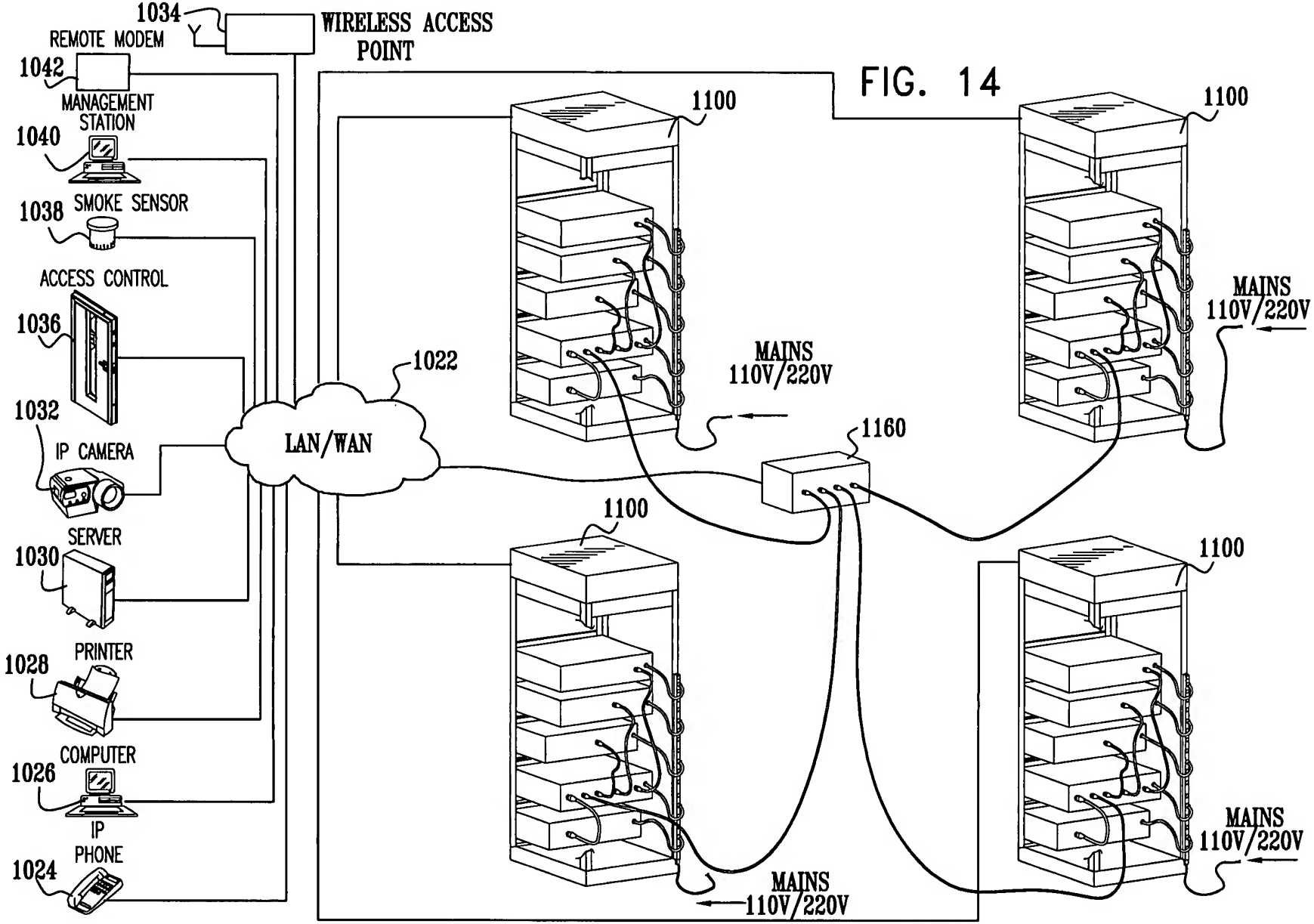

1034
WIRELESS ACCESS POINT
REMOTE MODEM
1042
MANAGEMENT STATION
1040
SMOKE SENSOR
1038
ACCESS CONTROL
1036
1032
IP CAMERA
SERVER
1030
PRINTER
1028
COMPUTER
1026
IP PHONE
1024
LAN/WAN
1022
1100
1100
MAINS 110V/220V
1160
1100
1100
MAINS 110V/220V
MAINS 110V/220V

FIG. 14

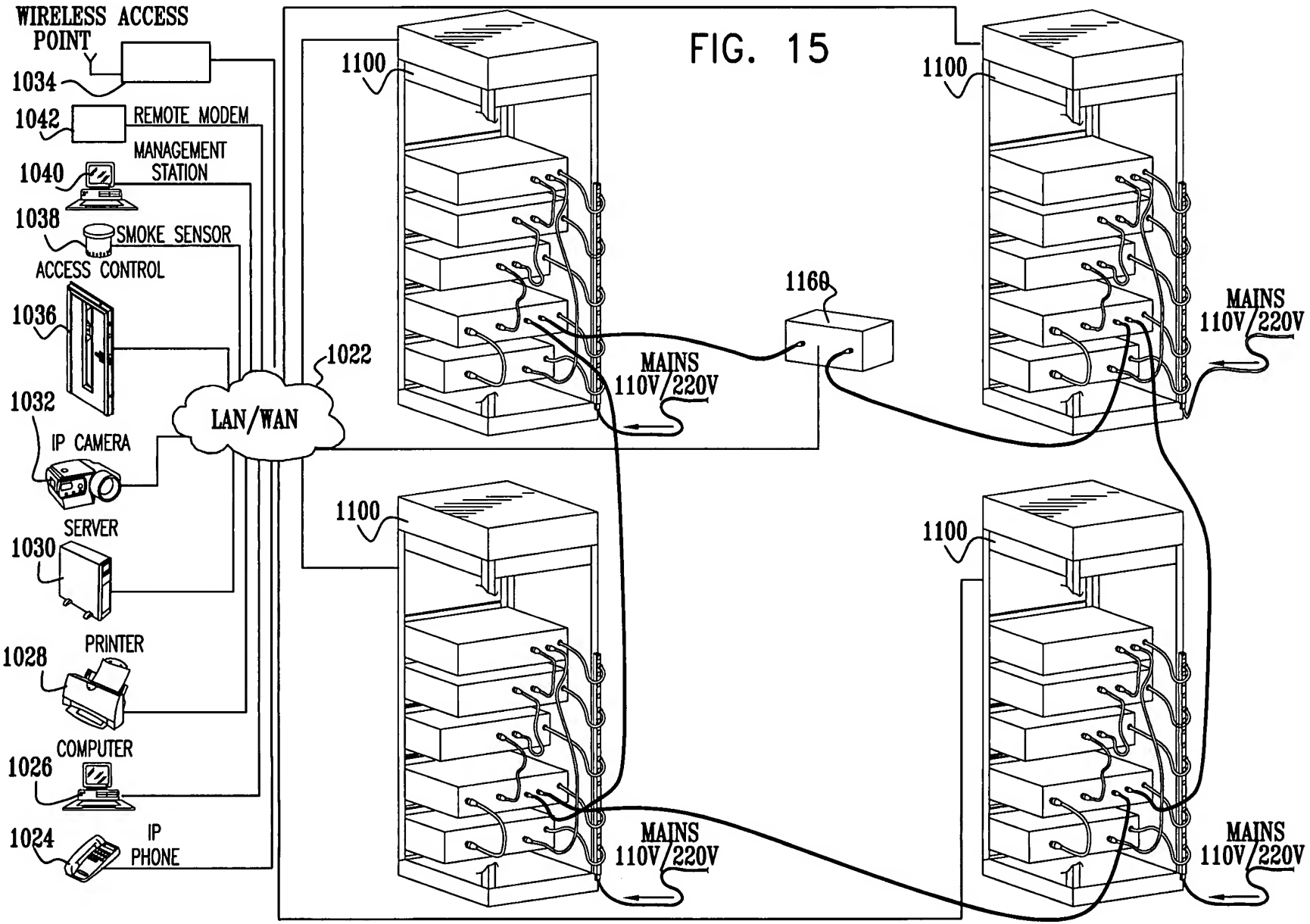

WIRELESS ACCESS POINT
1034
1042
REMOTE MODEM
MANAGEMENT STATION
1040
1038
SMOKE SENSOR
ACCESS CONTROL
1036
1032
IP CAMERA
SERVER
1030
PRINTER
1028
COMPUTER
1026
1024
IP PHONE
LAN/WAN
1022
1100
1100
1160
MAINS 110V/220V
MAINS 110V/220V
1100
1100
MAINS 110V/220V
MAINS 110V/220V

FIG. 15

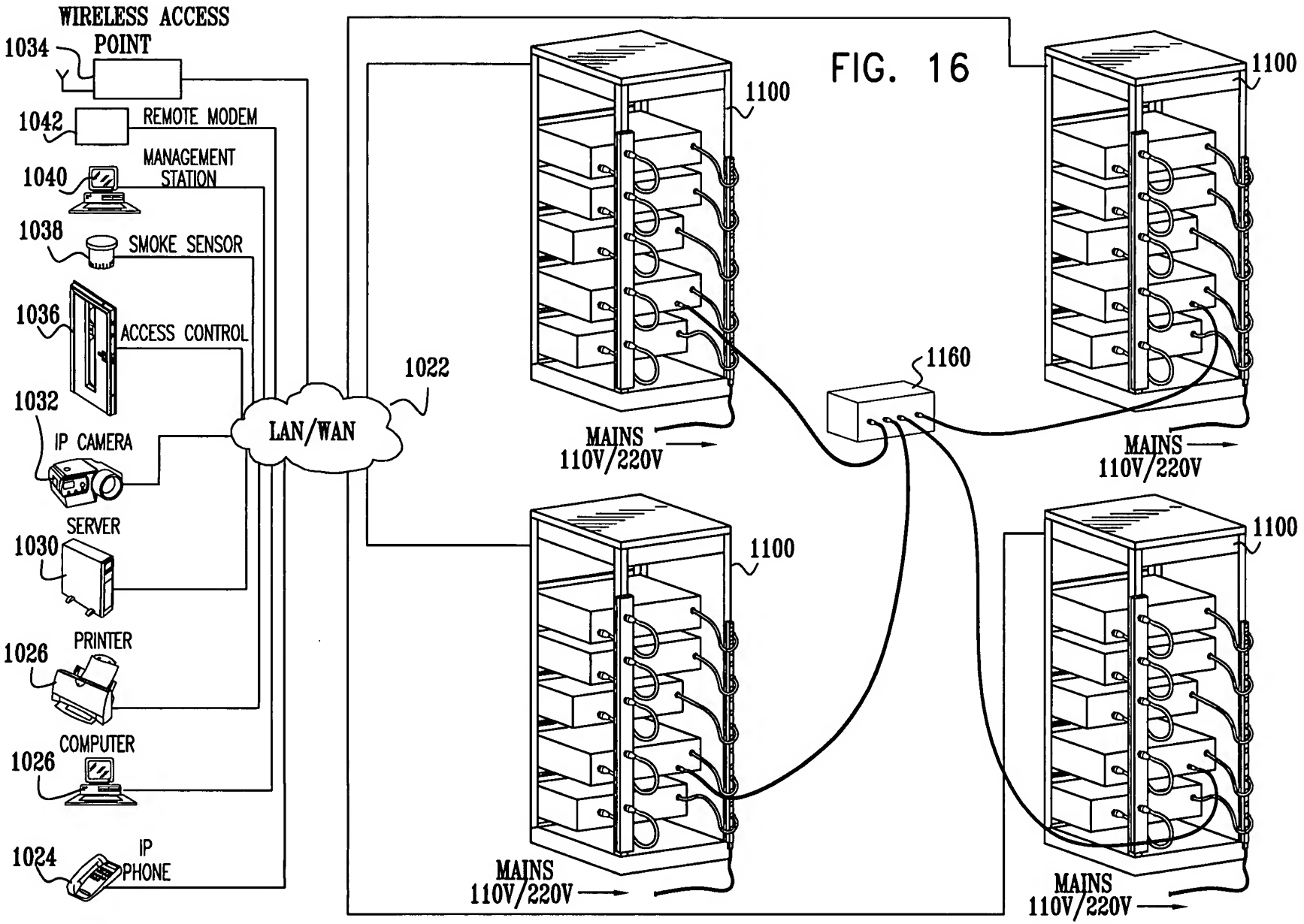

WIRELESS ACCESS POINT
1034
REMOTE MODEM
1042
MANAGEMENT STATION
1040
SMOKE SENSOR
1038
ACCESS CONTROL
1036
IP CAMERA
1032
SERVER
1030
PRINTER
1026
COMPUTER
1026
IP PHONE
1024
LAN/WAN
1022
1100
1100
1100
1100
1160
MAINS 110V/220V
MAINS 110V/220V
MAINS 110V/220V
MAINS 110V/220V

FIG. 16

FIG. 17

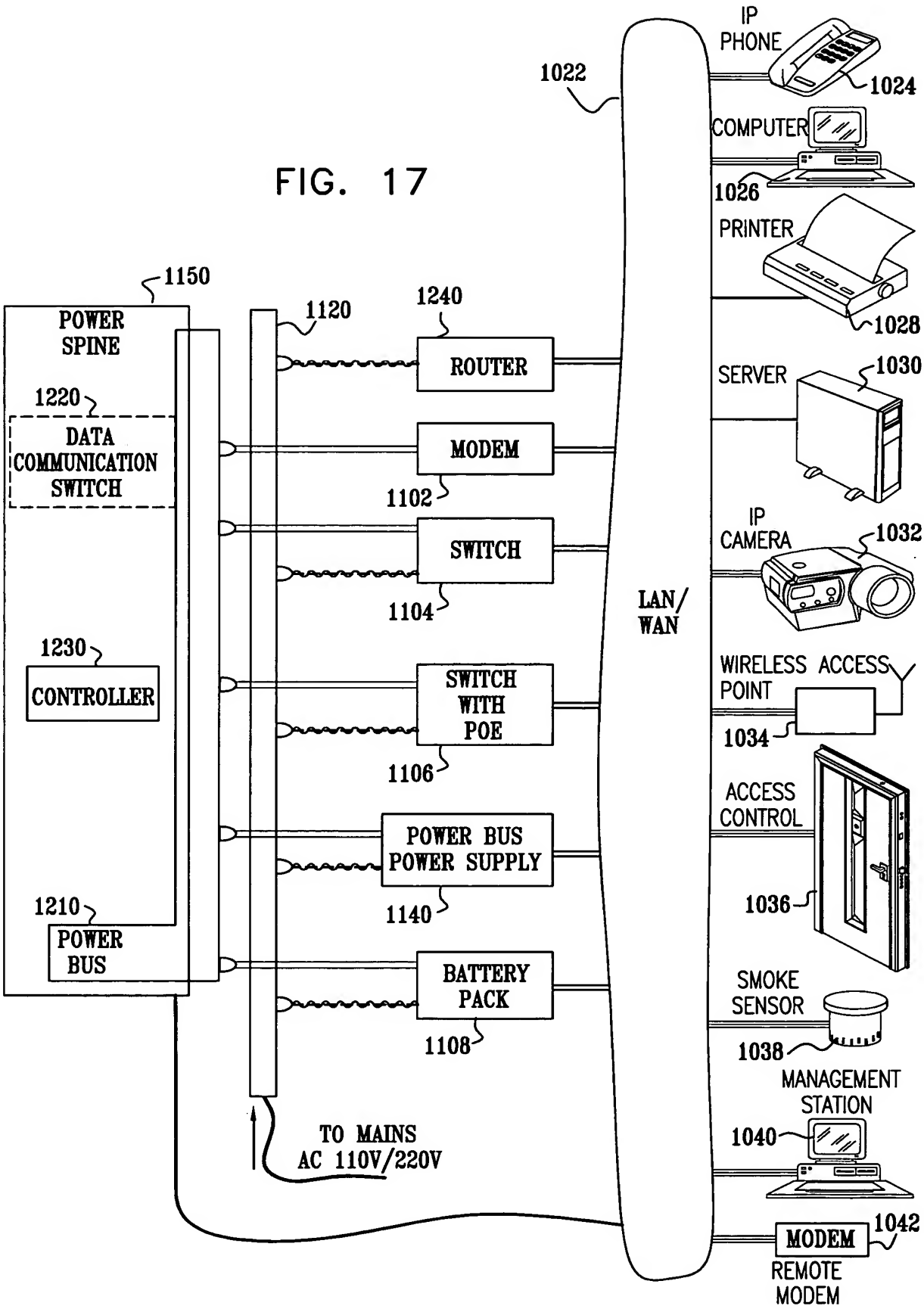

1150
POWER SPINE
1220
DATA COMMUNICATION SWITCH
1230
CONTROLLER
1210
POWER BUS
1120
1240
ROUTER
MODEM
1102
SWITCH
1104
SWITCH WITH POE
1106
POWER BUS POWER SUPPLY
1140
BATTERY PACK
1108
TO MAINS AC 110V/220V
1022
LAN/ WAN
IP PHONE
1024
COMPUTER
1026
PRINTER
1028
SERVER
1030
IP CAMERA
1032
WIRELESS ACCESS POINT
1034
ACCESS CONTROL
1036
SMOKE SENSOR
1038
MANAGEMENT STATION
1040
MODEM
1042
REMOTE MODEM

FIG. 18A

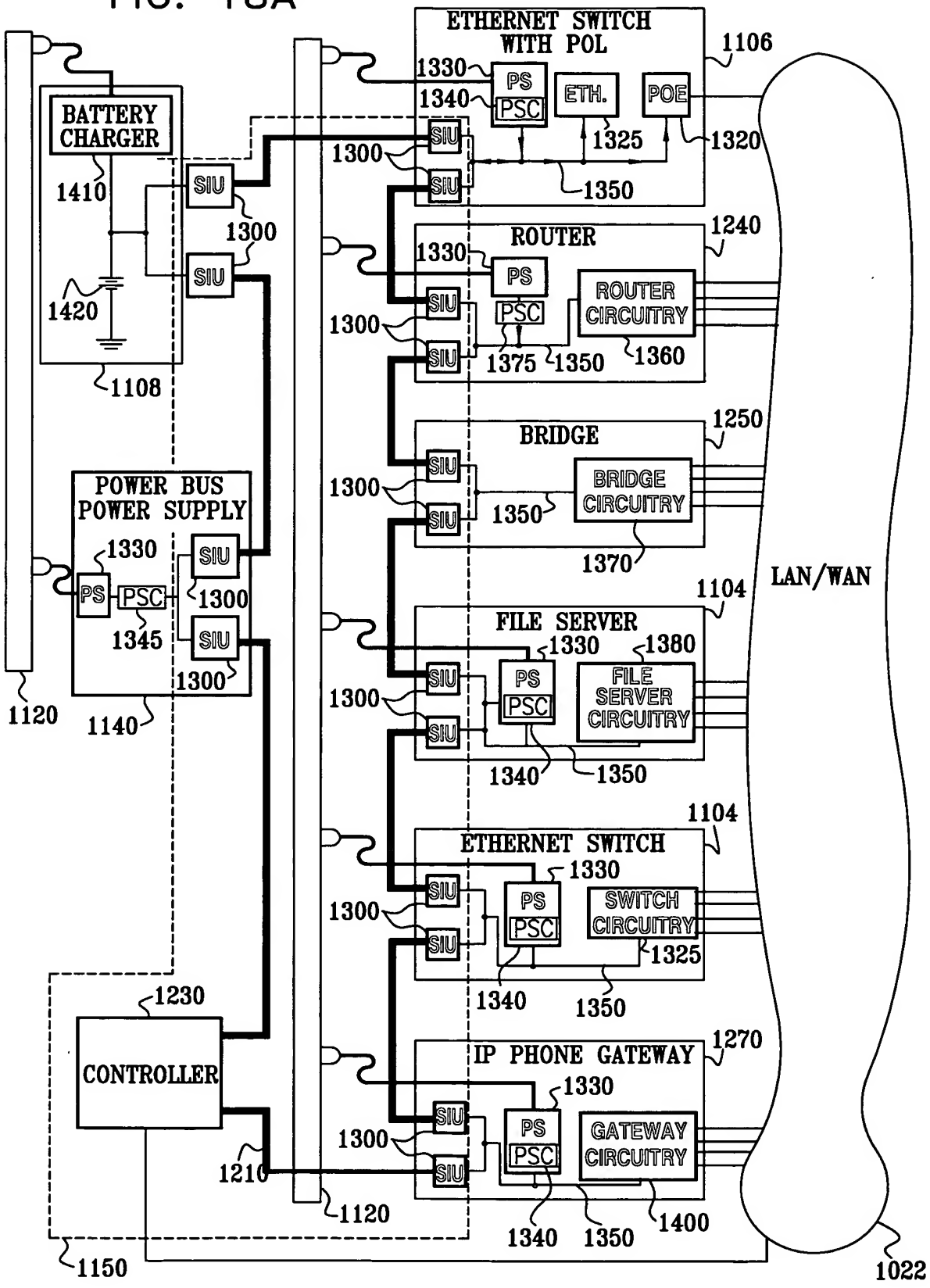

ETHERNET SWITCH WITH POL
1106
1330
PS
PSC
1340
ETH.
1325
POE
1320
1350
BATTERY CHARGER
1410
1420
1108
SIU
1300
ROUTER
1240
ROUTER CIRCUITRY
1375
1360
BRIDGE
1250
BRIDGE CIRCUITRY
1370
POWER BUS POWER SUPPLY
1345
1120
1140
LAN/WAN
1104
FILE SERVER
1380
FILE SERVER CIRCUITRY
ETHERNET SWITCH
SWITCH CIRCUITRY
1230
CONTROLLER
1210
IP PHONE GATEWAY
1270
GATEWAY CIRCUITRY
1400
1150
1022

FIG. 18B

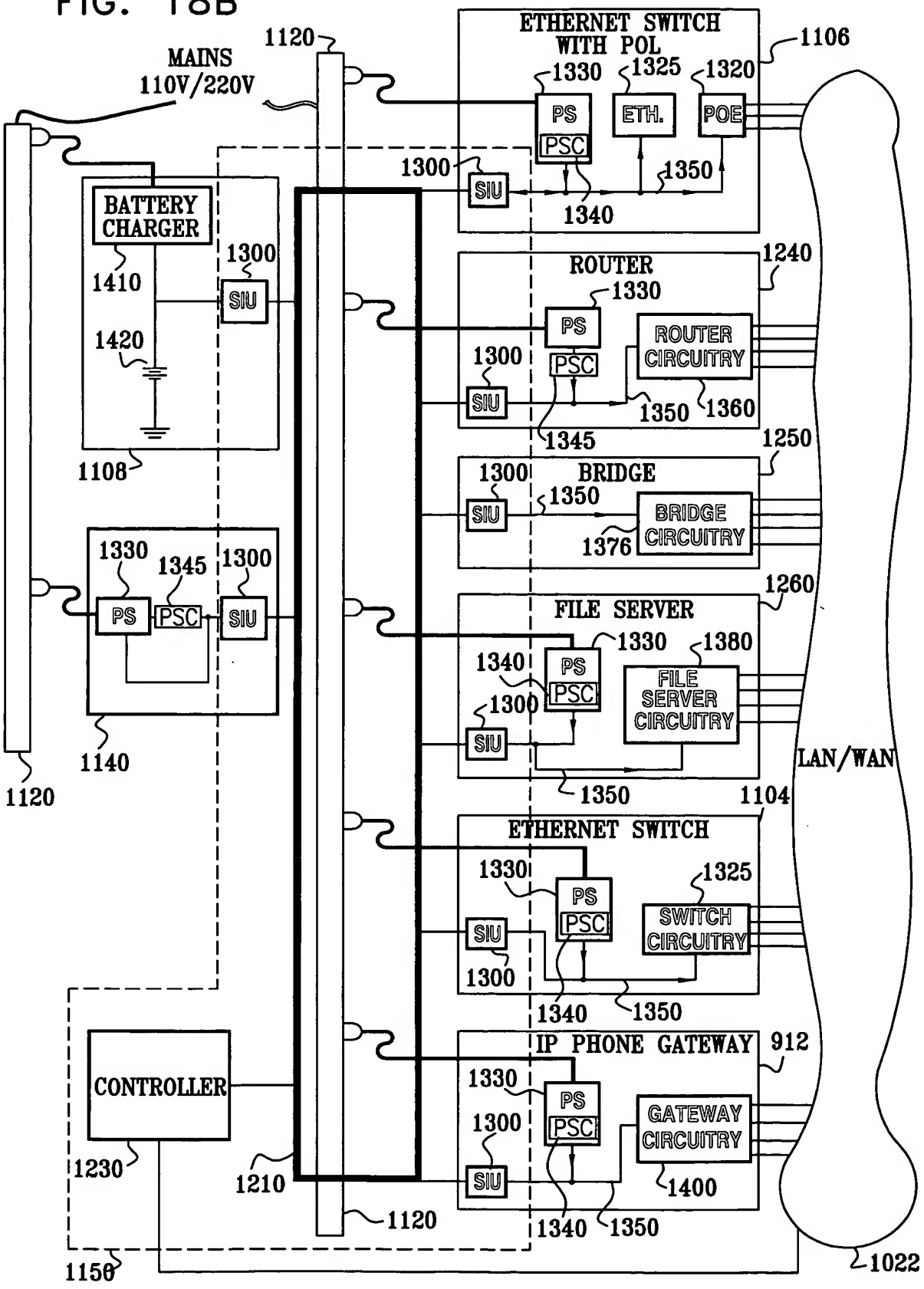

MAINS
110V/220V
1120
ETHERNET SWITCH
WITH POL
1106
1330
1325
1320
PS
PSC
ETH.
POE
1300
SIU
1350
1340
BATTERY
CHARGER
1410
1420
1108
ROUTER
1240
1330
ROUTER
CIRCUITRY
1345
1360
1250
BRIDGE
1376
BRIDGE
CIRCUITRY
1140
1260
FILE SERVER
1380
FILE
SERVER
CIRCUITRY
LAN/WAN
1104
ETHERNET SWITCH
SWITCH
CIRCUITRY
CONTROLLER
1230
1210
IP PHONE GATEWAY
912
GATEWAY
CIRCUITRY
1400
1150
1022

FIG. 19A

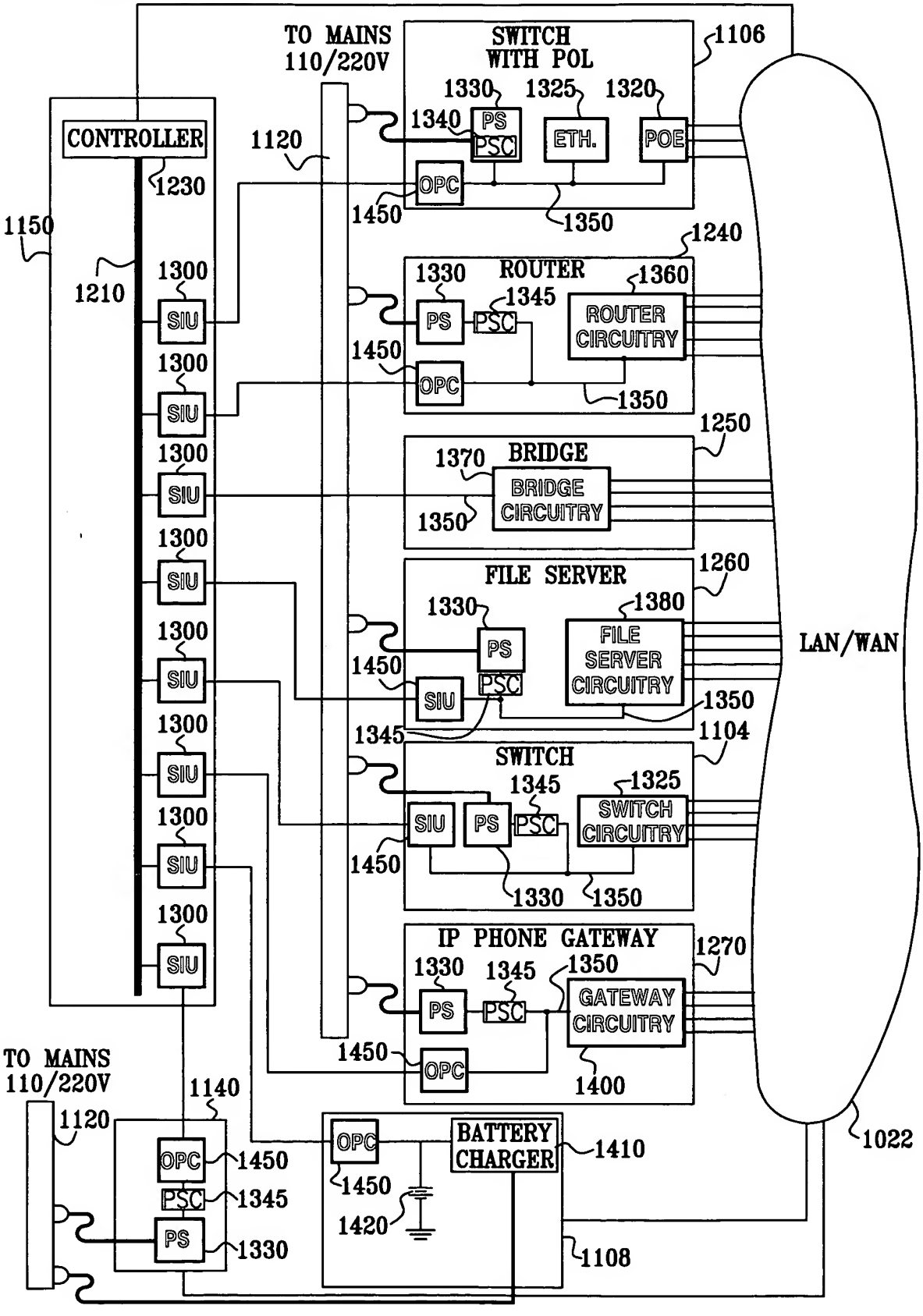

TO MAINS 110/220V
SWITCH WITH POL
1106
1330
1325
1320
1340
PS
PSC
ETH.
POE
CONTROLLER
1230
1120
OPC
1450
1350
1150
1240
1210
1300
ROUTER
1360
1330
1345
PS
PSC
ROUTER CIRCUITRY
SIU
1450
OPC
1350
1250
1370
BRIDGE
BRIDGE CIRCUITRY
1350
1260
FILE SERVER
1330
1380
PS
FILE SERVER CIRCUITRY
1450
SIU
PSC
1350
1345
1104
SWITCH
1345
1325
SIU
PS
PSC
SWITCH CIRCUITRY
1450
1330
1350
IP PHONE GATEWAY
1270
1330
1345
1350
PS
PSC
GATEWAY CIRCUITRY
1450
OPC
1400
LAN/WAN
TO MAINS 110/220V
1140
1120
OPC
1450
PSC
1345
PS
1330
OPC
BATTERY CHARGER
1410
1450
1420
1108
1022

FIG. 19B

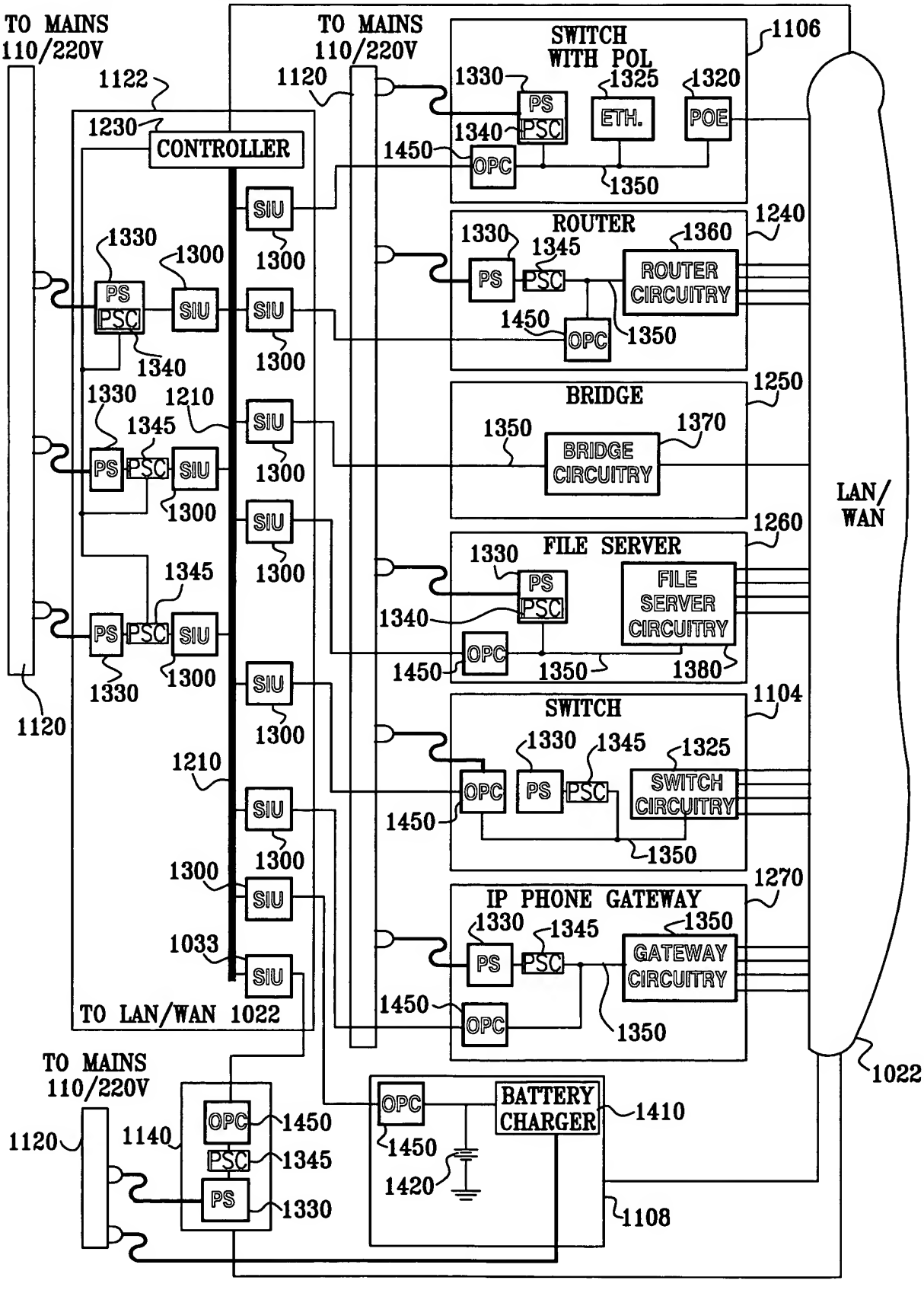

TO MAINS 110/220V
1122
1230
CONTROLLER
1120
TO MAINS 110/220V
SWITCH WITH POL
1106
1330
1325
1320
PS
PSC
ETH.
POE
1340
1450
OPC
1350
SIU
1300
1330
1300
PS
PSC
SIU
1340
ROUTER
1240
1330
1345
1360
PS
PSC
ROUTER CIRCUITRY
1450
OPC
1350
1330
1210
1345
BRIDGE
1250
1350
1370
BRIDGE CIRCUITRY
LAN/ WAN
FILE SERVER
1260
1330
PS
PSC
FILE SERVER CIRCUITRY
1340
OPC
1450
1350
1380
1345
1330
SWITCH
1104
1330
1345
1325
OPC
PS
PSC
SWITCH CIRCUITRY
1450
1350
1210
1300
IP PHONE GATEWAY
1270
1330
1345
1350
PS
PSC
GATEWAY CIRCUITRY
1033
1450
OPC
1350
TO LAN/WAN 1022
1022
TO MAINS 110/220V
1120
1140
OPC
1450
PSC
1345
PS
1330
BATTERY CHARGER
1410
1420
1108

FIG. 20A

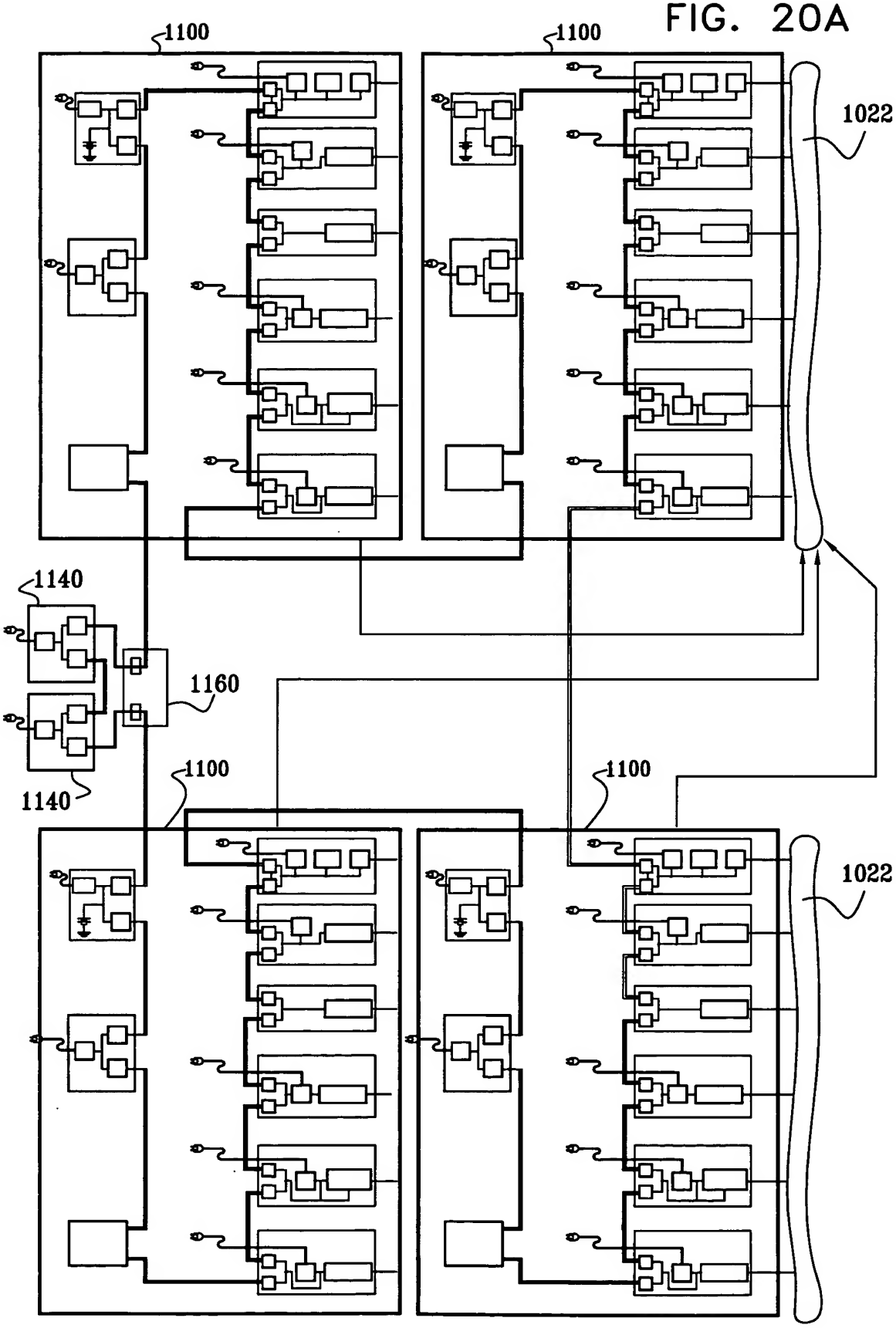


FIG. 20B

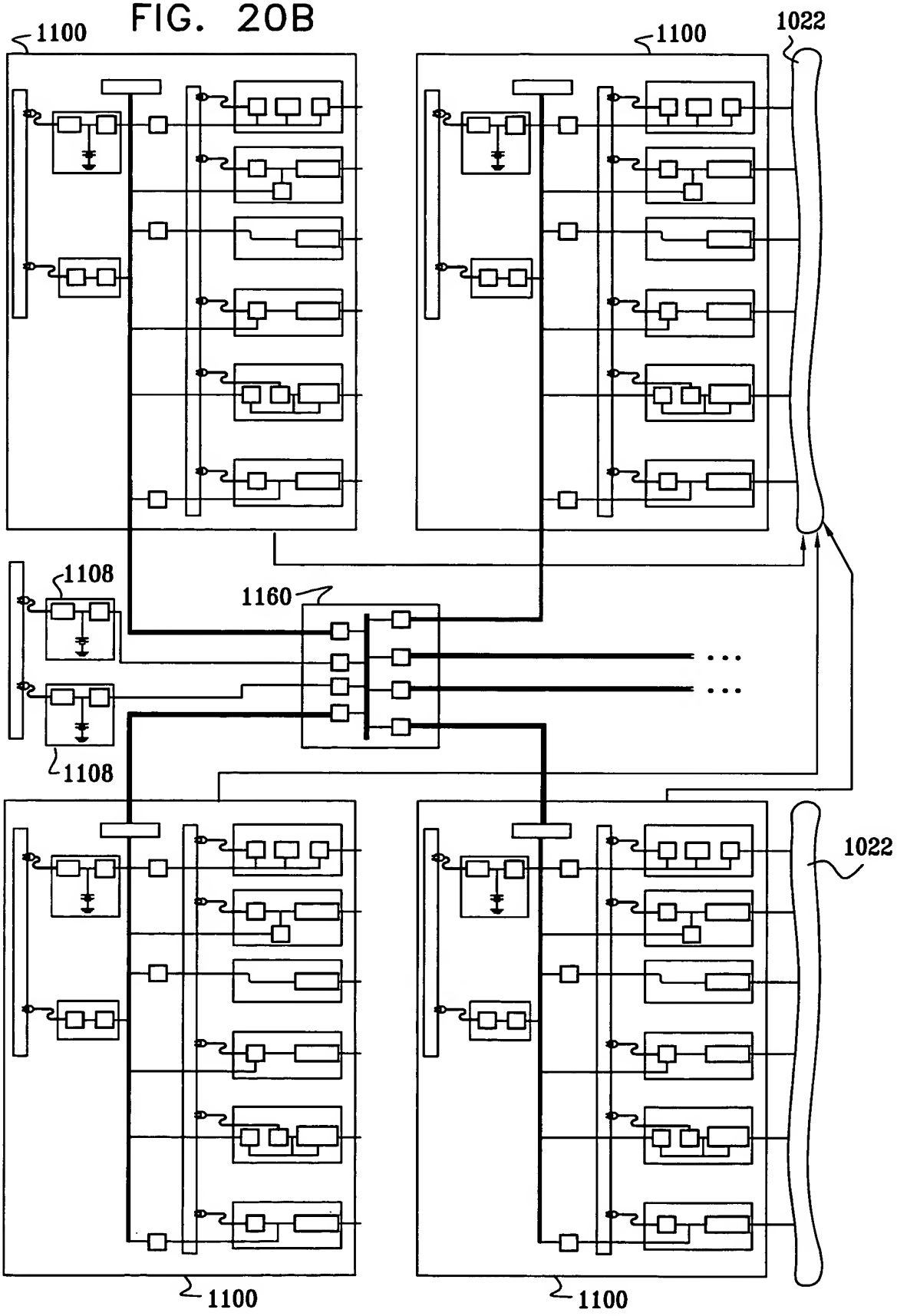


FIG. 21A

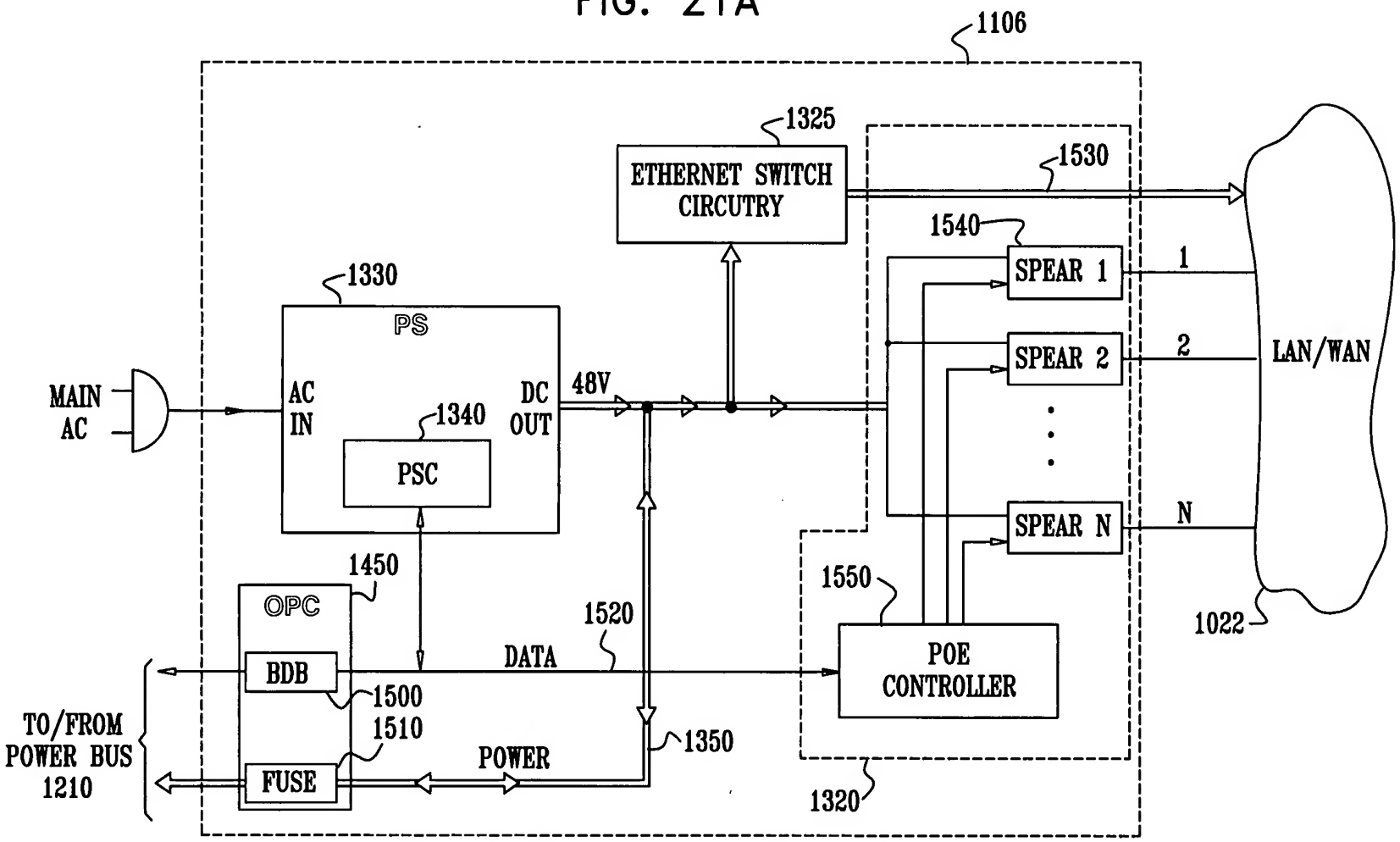

1106
1325
ETHERNET SWITCH CIRCUTRY
1530
1540
SPEAR 1
SPEAR 2
SPEAR N
1
2
N
LAN/WAN
1022
1330
PS
MAIN AC
AC IN
DC OUT
48V
1340
PSC
1450
OPC
BDB
1500
1510
FUSE
TO/FROM POWER BUS 1210
DATA
1520
POWER
1350
1550
POE CONTROLLER
1320

FIG. 21B

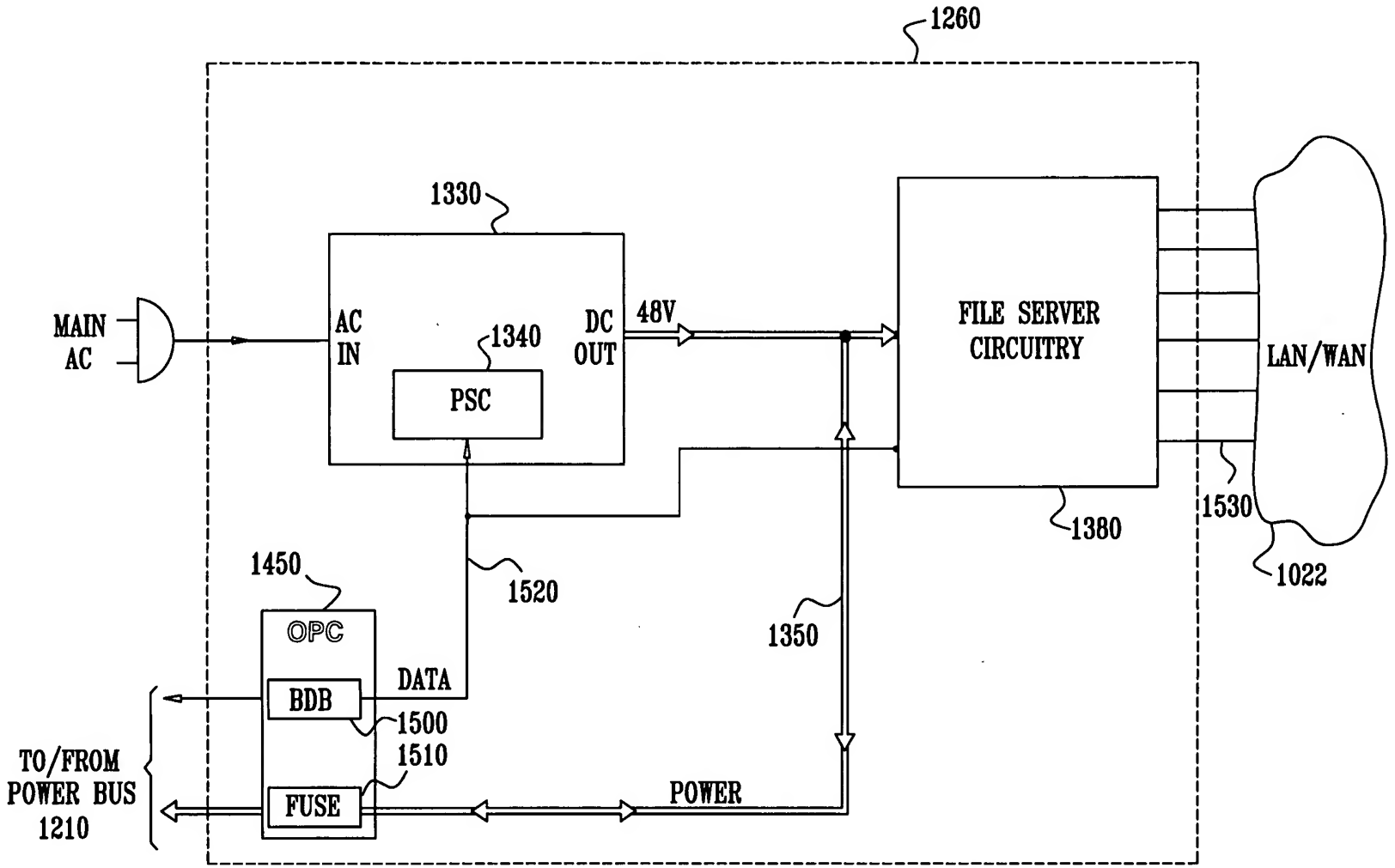

1260
1330
MAIN AC
AC IN
1340
PSC
DC OUT
48V
FILE SERVER CIRCUITRY
LAN/WAN
1530
1380
1022
1450
OPC
1520
1350
DATA
BDB
1500
1510
TO/FROM POWER BUS 1210
FUSE
POWER

FIG. 21C

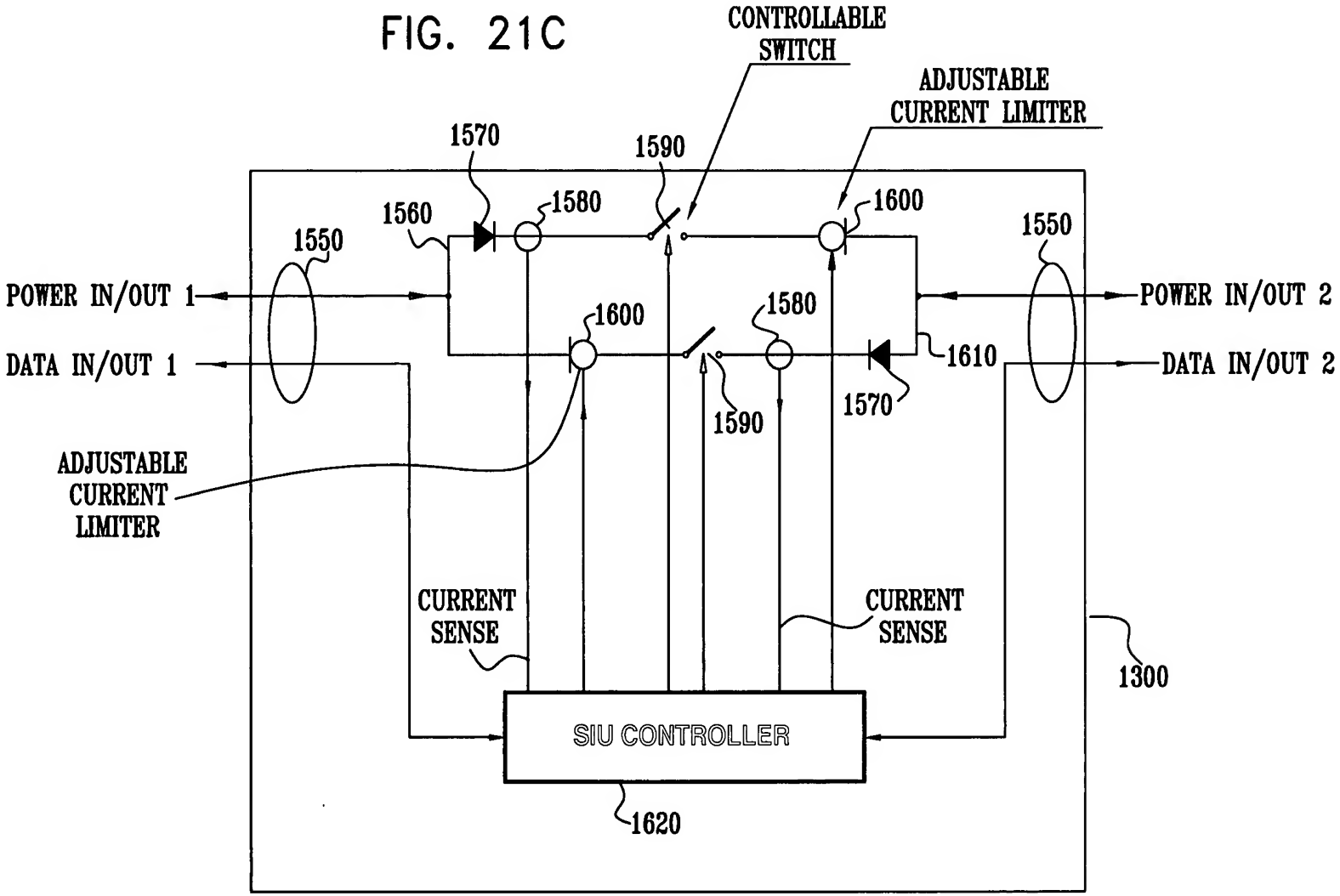

CONTROLLABLE SWITCH
ADJUSTABLE CURRENT LIMITER
1570
1590
1560
1580
1600
1550
1550
POWER IN/OUT 1
POWER IN/OUT 2
1600
1580
DATA IN/OUT 1
1610
DATA IN/OUT 2
1590
1570
ADJUSTABLE CURRENT LIMITER
CURRENT SENSE
CURRENT SENSE
1300
SIU CONTROLLER
1620

FIG. 21D

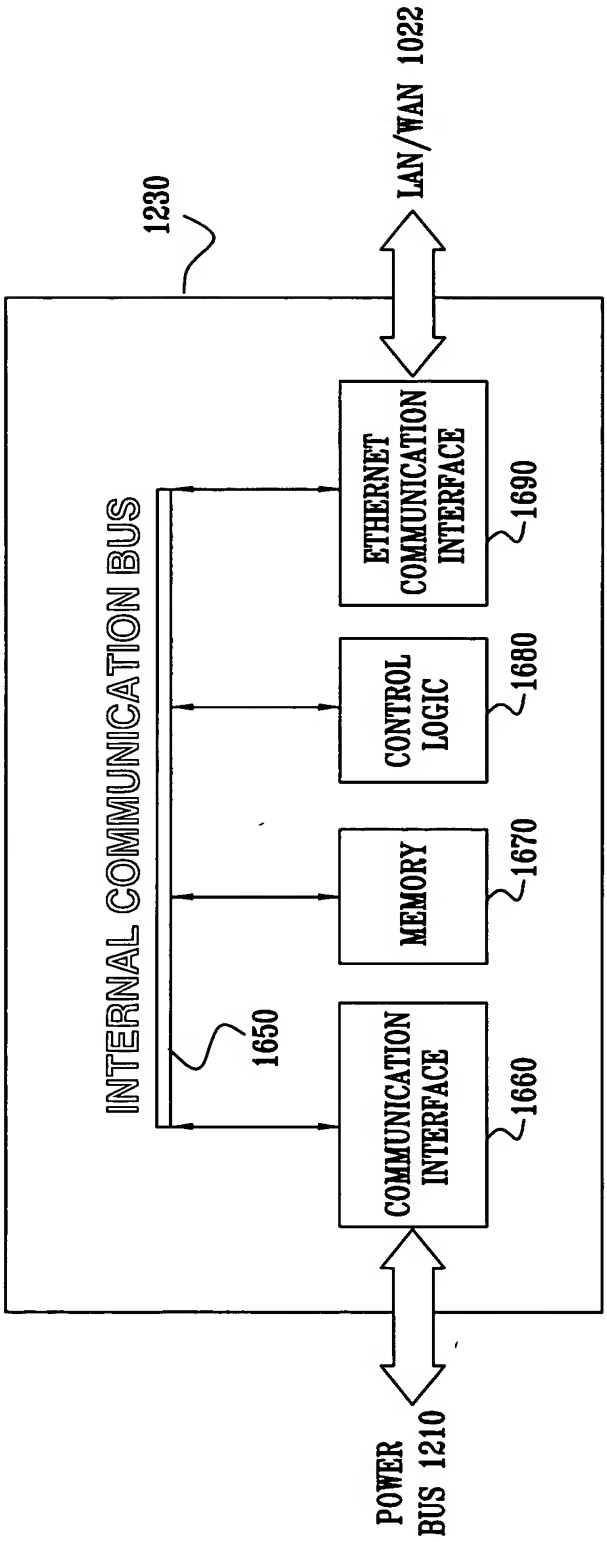

1230
LAN/WAN 1022
ETHERNET COMMUNICATION INTERFACE
1690
CONTROL LOGIC
1680
MEMORY
1670
COMMUNICATION INTERFACE
1660
INTERNAL COMMUNICATION BUS
1650
POWER BUS 1210

FIG. 21E

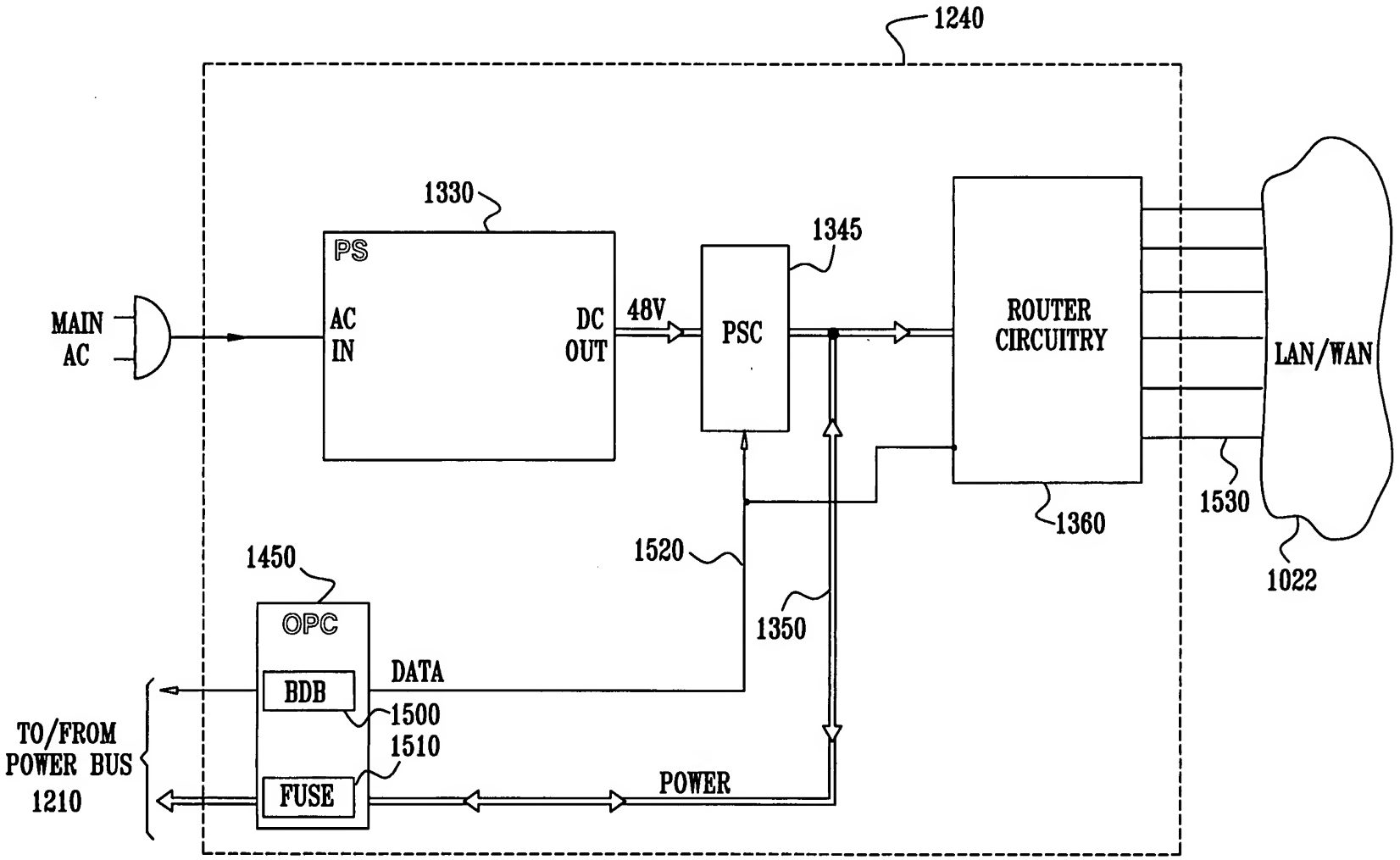

1240
1330
PS
AC
IN
DC
OUT
48V
1345
PSC
ROUTER
CIRCUITRY
LAN/WAN
MAIN
AC
1530
1360
1022
1520
1450
OPC
1350
DATA
BDB
1500
1510
TO/FROM
POWER BUS
1210
FUSE
POWER

FIG. 21F

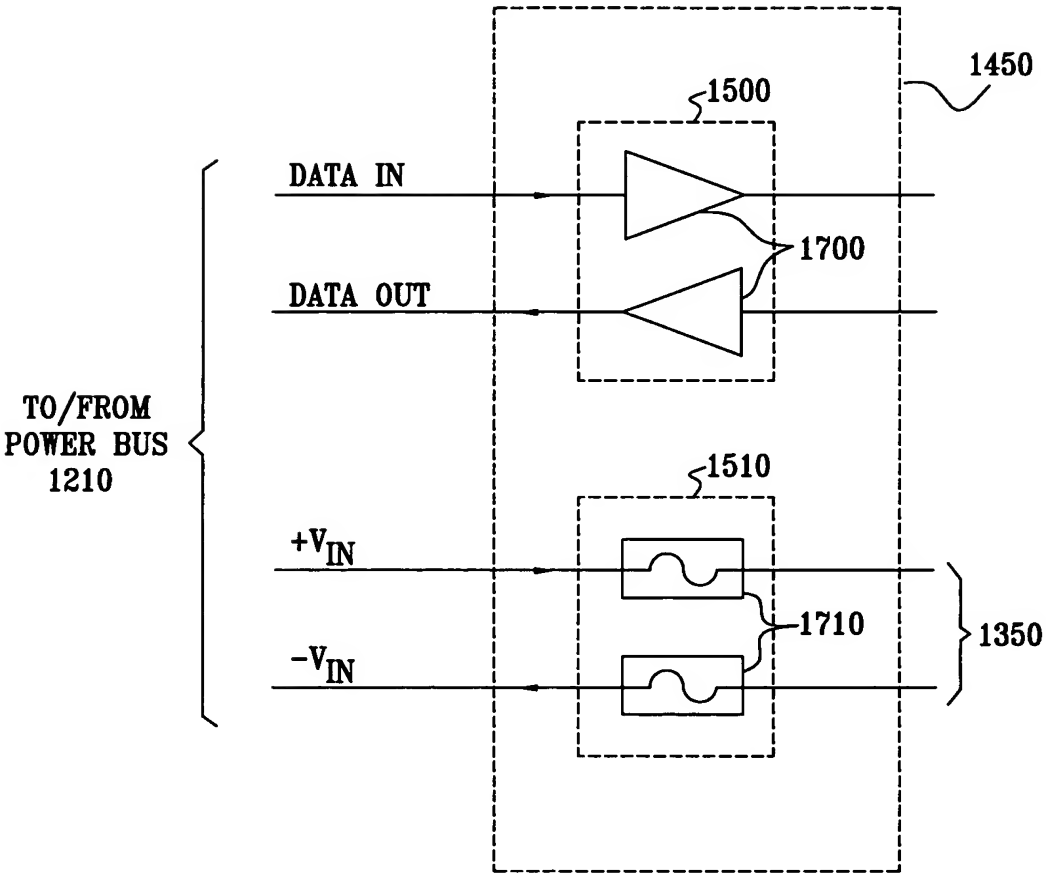

1450
1500
DATA IN
1700
DATA OUT
TO/FROM
POWER BUS
1210
1510
+V_IN
1710
1350
-V_IN

FIG. 22A

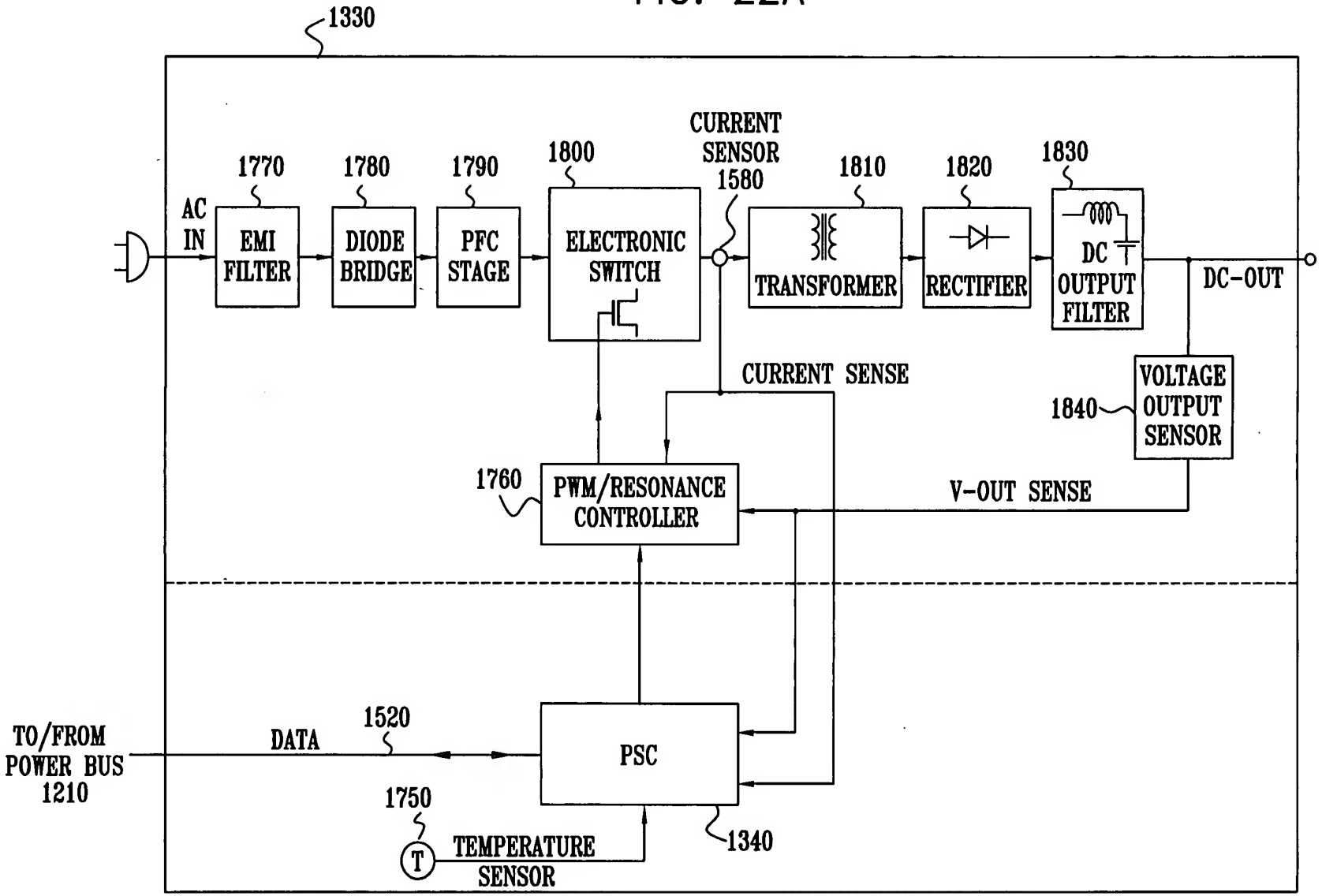

1330
AC IN
1770
EMI FILTER
1780
DIODE BRIDGE
1790
PFC STAGE
1800
ELECTRONIC SWITCH
CURRENT SENSOR 1580
1810
TRANSFORMER
1820
RECTIFIER
1830
DC OUTPUT FILTER
DC-OUT
CURRENT SENSE
1840
VOLTAGE OUTPUT SENSOR
1760
PWM/RESONANCE CONTROLLER
V-OUT SENSE
TO/FROM POWER BUS 1210
DATA
1520
PSC
1750
T
TEMPERATURE SENSOR
1340

FIG. 22B

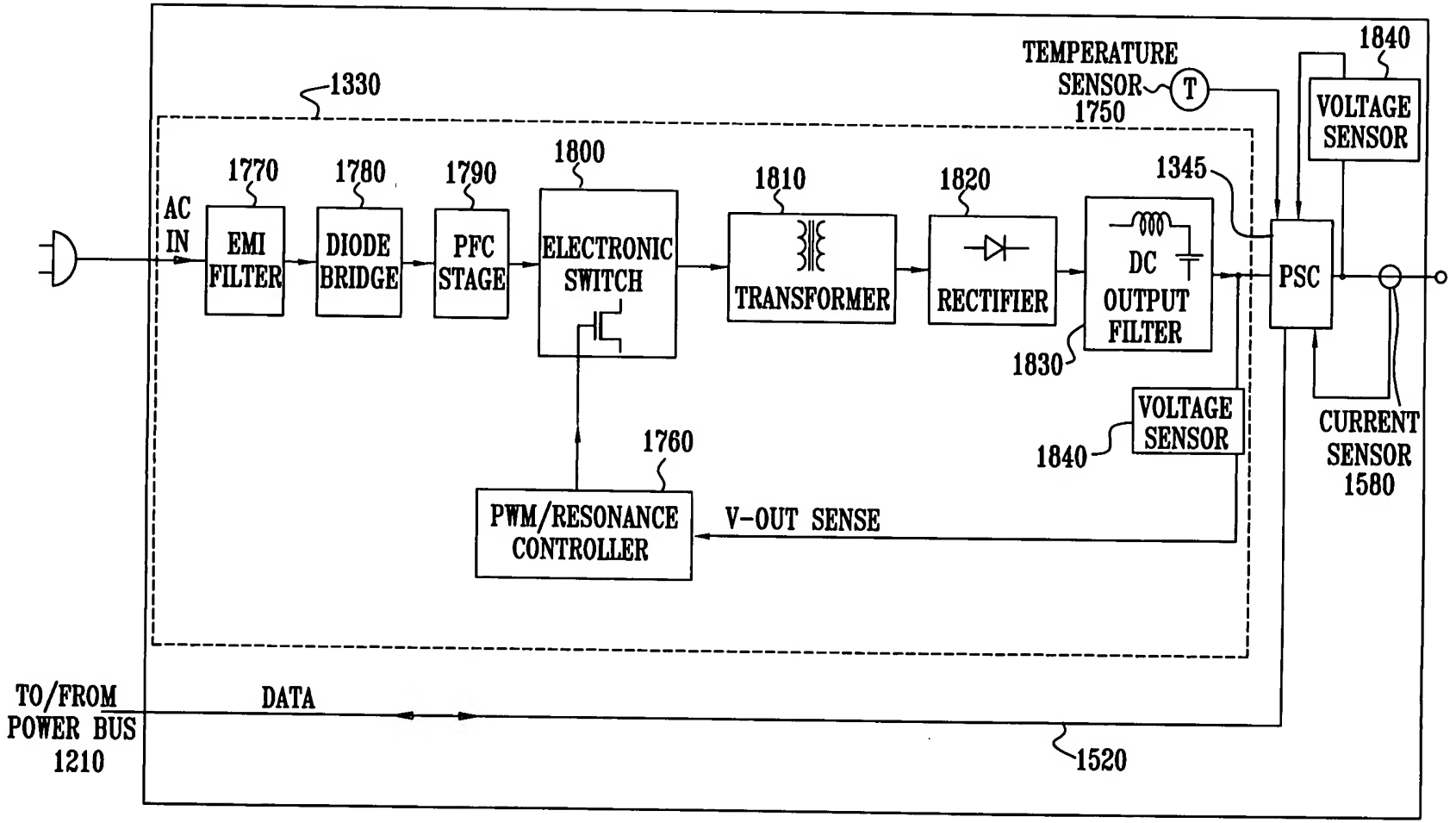

1330
TEMPERATURE SENSOR 1750
T
1840
VOLTAGE SENSOR
1770
1780
1790
1800
1810
1820
1345
AC IN
EMI FILTER
DIODE BRIDGE
PFC STAGE
ELECTRONIC SWITCH
TRANSFORMER
RECTIFIER
DC OUTPUT FILTER
PSC
1830
VOLTAGE SENSOR
1840
CURRENT SENSOR 1580
1760
PWM/RESONANCE CONTROLLER
V-OUT SENSE
TO/FROM POWER BUS 1210
DATA
1520

FIG. 23A

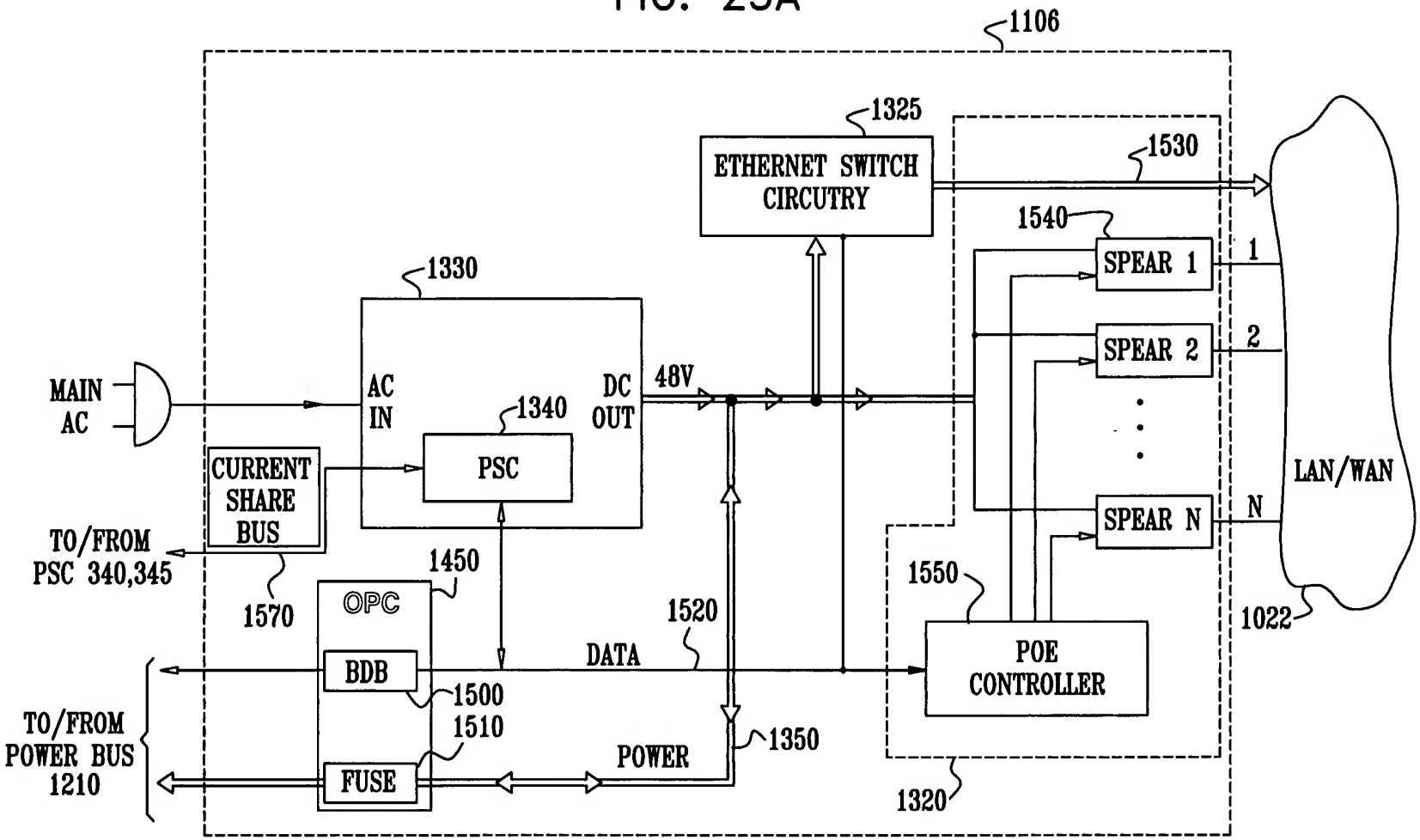

1106
1325
ETHERNET SWITCH CIRCUTRY
1530
1540
SPEAR 1
SPEAR 2
SPEAR N
1
2
N
LAN/WAN
1022
1330
MAIN AC
AC IN
DC OUT
48V
1340
PSC
CURRENT SHARE BUS
TO/FROM PSC 340,345
1570
1450
OPC
BDB
1500
1510
FUSE
TO/FROM POWER BUS 1210
1520
DATA
POWER
1350
1550
POE CONTROLLER
1320

FIG. 23B

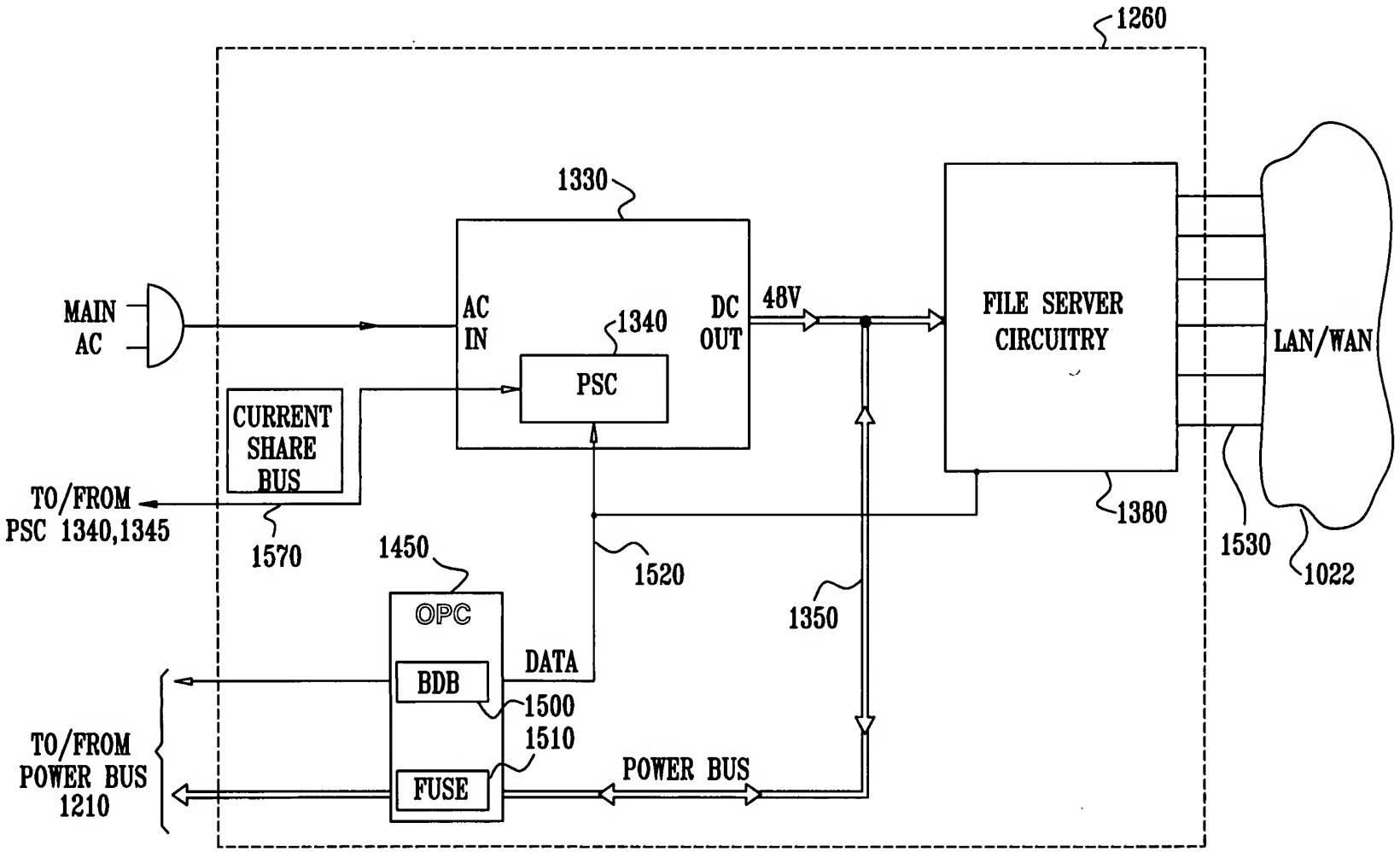

1260
1330
MAIN AC
AC IN
1340
PSC
DC OUT
48V
FILE SERVER CIRCUITRY
LAN/WAN
CURRENT SHARE BUS
TO/FROM PSC 1340,1345
1570
1450
OPC
BDB
DATA
1500
1510
FUSE
POWER BUS
TO/FROM POWER BUS 1210
1520
1350
1380
1530
1022

FIG. 23C

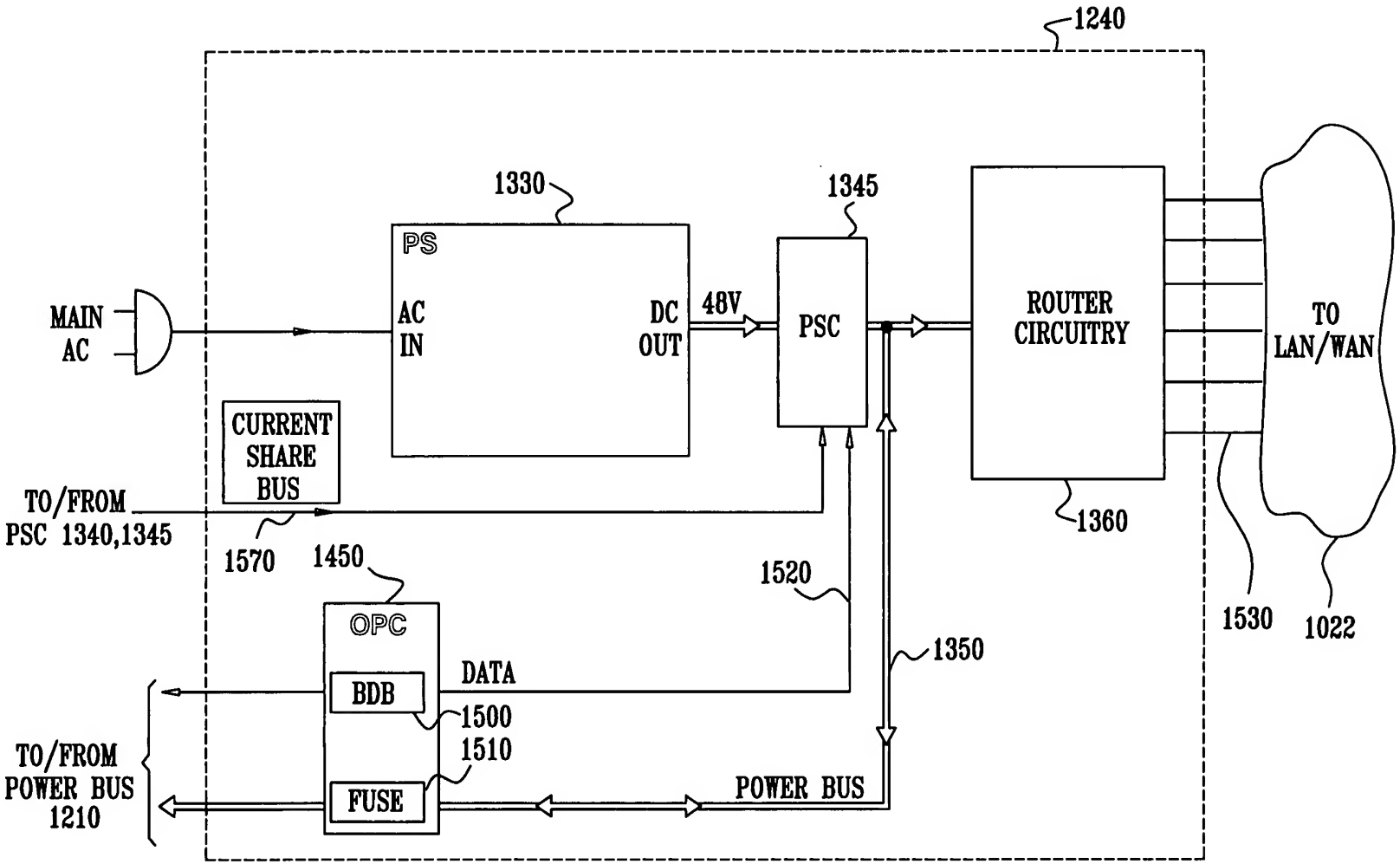

1240
1330
1345
PS
AC
IN
DC
OUT
48V
PSC
ROUTER
CIRCUITRY
TO
LAN/WAN
MAIN
AC
CURRENT
SHARE
BUS
TO/FROM
PSC 1340,1345
1570
1450
OPC
BDB
1500
1510
FUSE
DATA
1520
1350
POWER BUS
1360
1530
1022
TO/FROM
POWER BUS
1210

FIG. 24A

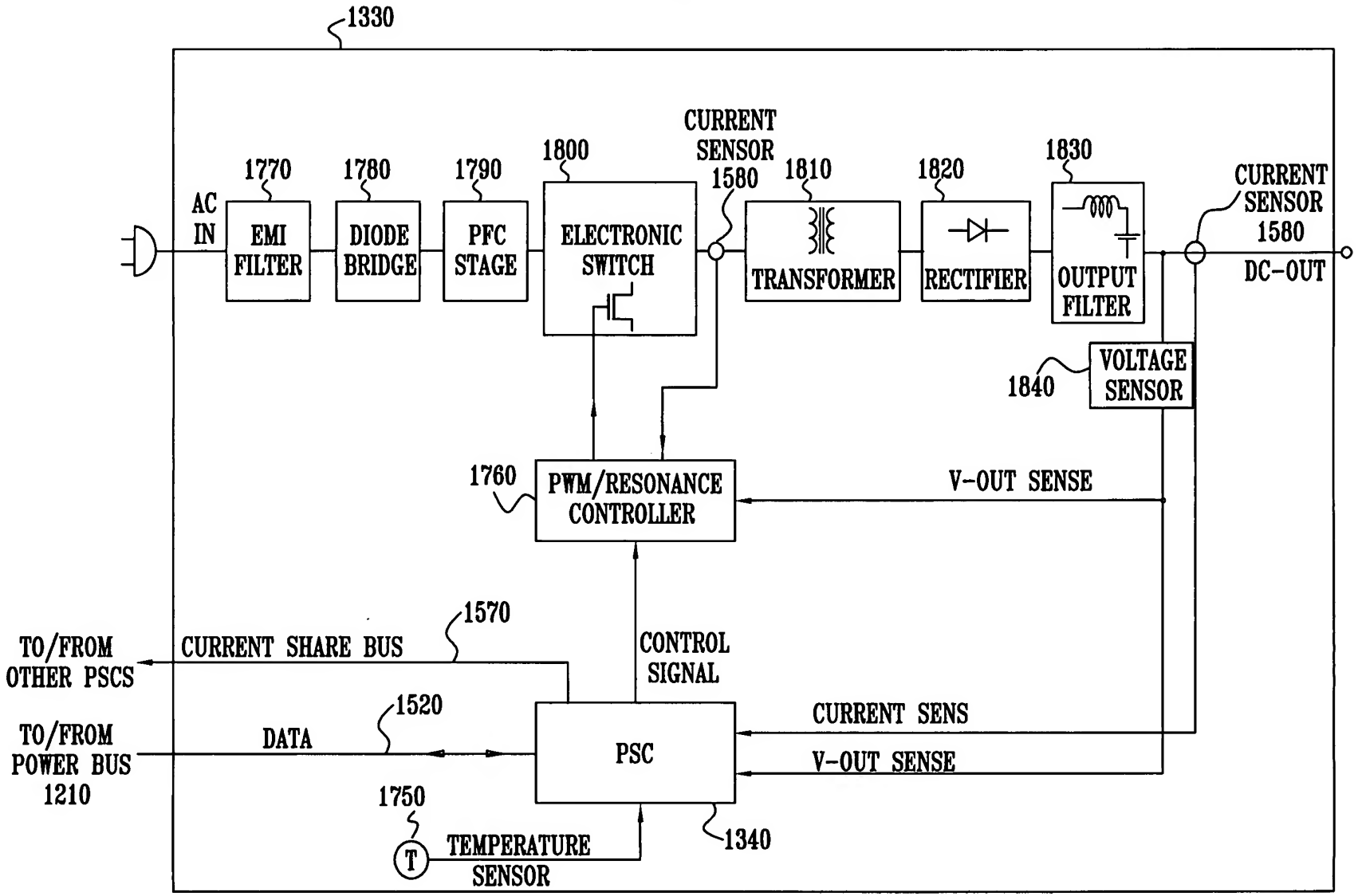

1330
AC IN
1770
EMI FILTER
1780
DIODE BRIDGE
1790
PFC STAGE
1800
ELECTRONIC SWITCH
CURRENT SENSOR 1580
1810
TRANSFORMER
1820
RECTIFIER
1830
OUTPUT FILTER
CURRENT SENSOR 1580
DC-OUT
1840
VOLTAGE SENSOR
1760
PWM/RESONANCE CONTROLLER
V-OUT SENSE
1570
CURRENT SHARE BUS
TO/FROM OTHER PSCS
CONTROL SIGNAL
1520
DATA
TO/FROM POWER BUS 1210
PSC
CURRENT SENS
V-OUT SENSE
1750
T
TEMPERATURE SENSOR
1340

FIG. 24B

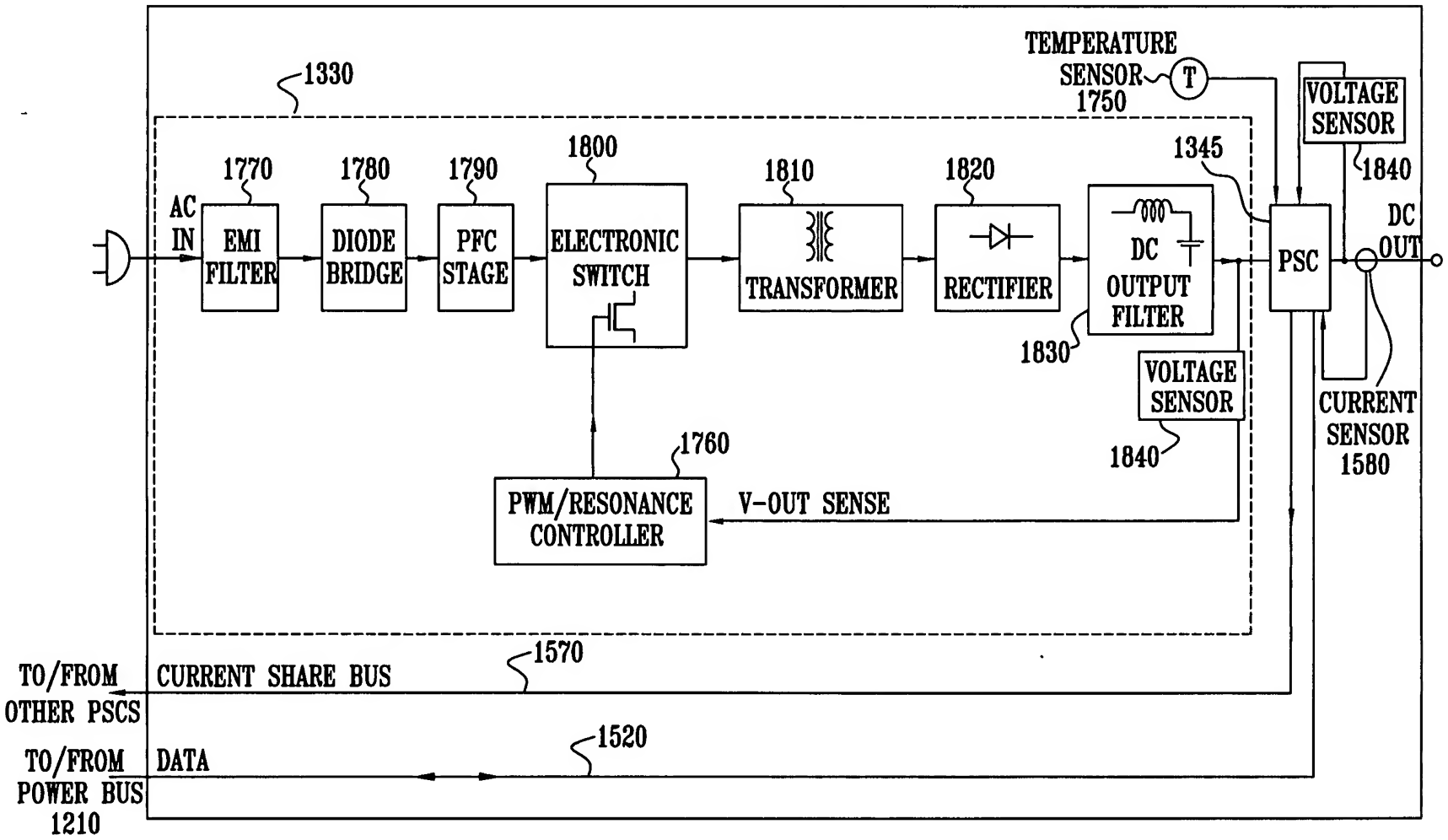

1330
TEMPERATURE SENSOR
T
1750
VOLTAGE SENSOR
1840
1345
1770
1780
1790
1800
1810
1820
AC IN
EMI FILTER
DIODE BRIDGE
PFC STAGE
ELECTRONIC SWITCH
TRANSFORMER
RECTIFIER
DC OUTPUT FILTER
PSC
DC OUT
1830
VOLTAGE SENSOR
1840
CURRENT SENSOR
1580
1760
PWM/RESONANCE CONTROLLER
V-OUT SENSE
1570
TO/FROM OTHER PSCS
CURRENT SHARE BUS
1520
TO/FROM POWER BUS 1210
DATA

FIG. 25A

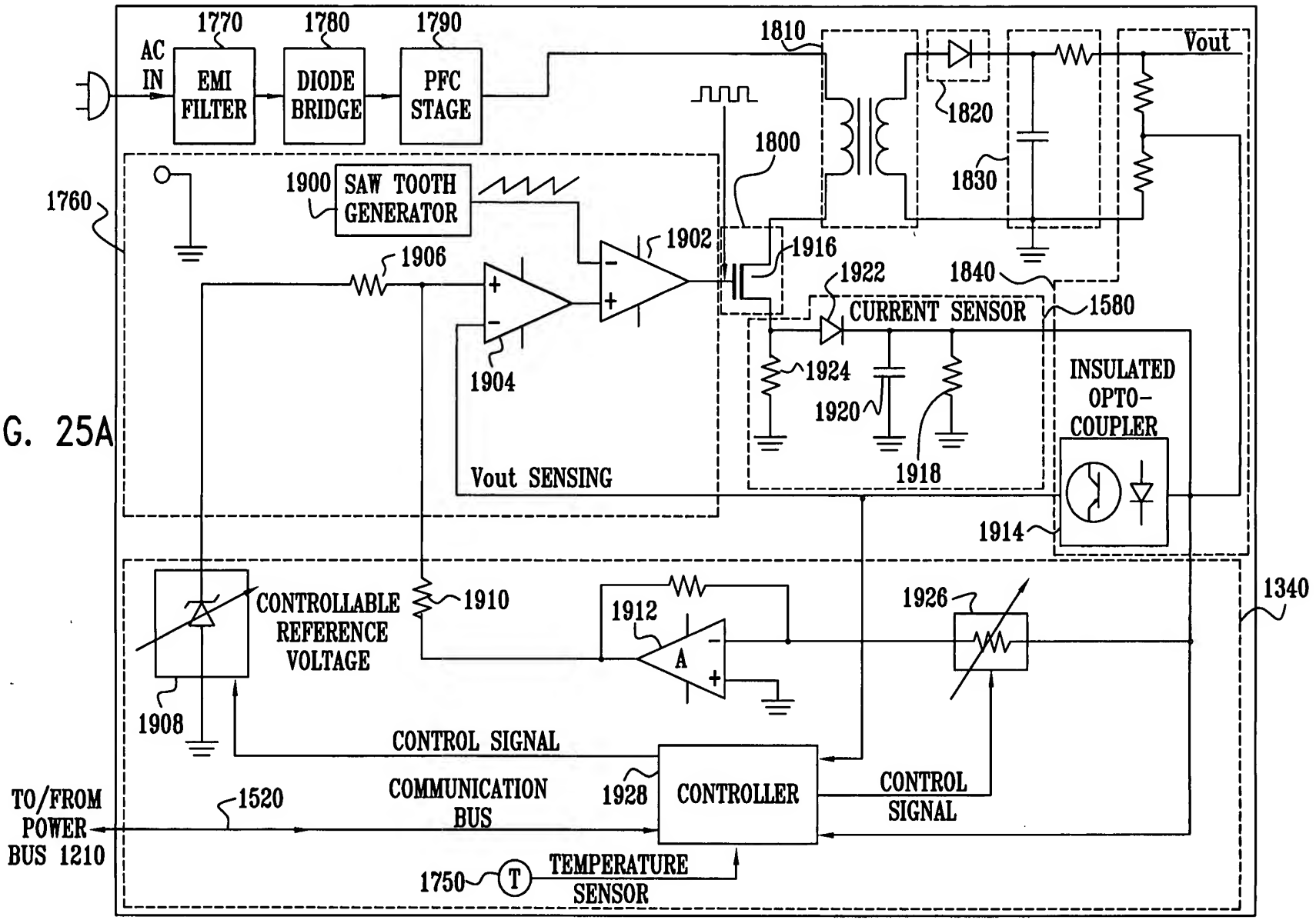

AC IN
1770
EMI FILTER
1780
DIODE BRIDGE
1790
PFC STAGE
1810
Vout
1820
1830
1800
1760
1900
SAW TOOTH GENERATOR
1902
1906
1916
1922
1840
CURRENT SENSOR
1580
1904
1924
1920
1918
INSULATED OPTO-COUPLER
Vout SENSING
1914
1340
CONTROLLABLE REFERENCE VOLTAGE
1910
1912
A
1926
1908
CONTROL SIGNAL
TO/FROM POWER BUS 1210
1520
COMMUNICATION BUS
1928
CONTROLLER
CONTROL SIGNAL
1750
T
TEMPERATURE SENSOR

FIG. 25B

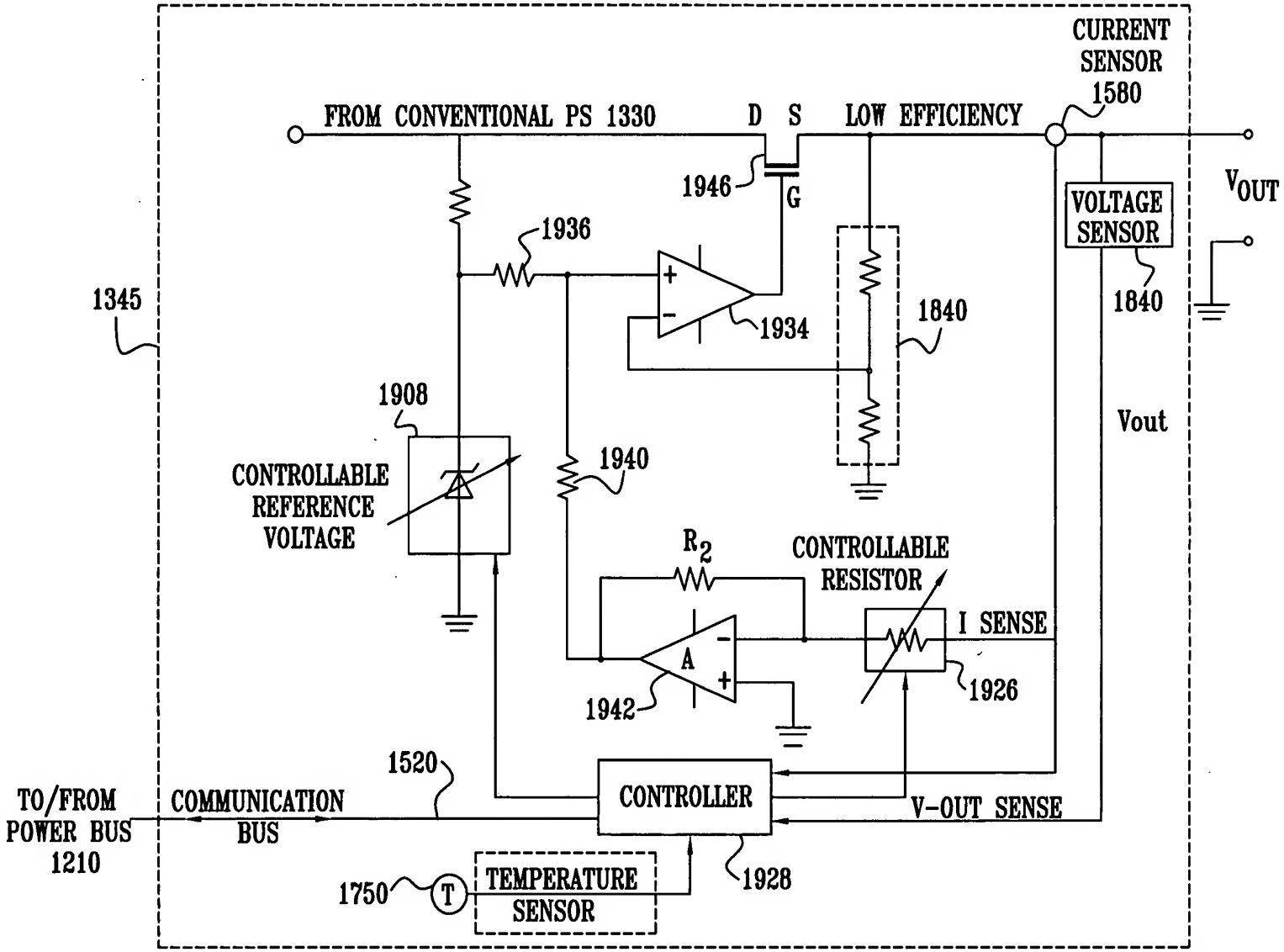

CURRENT SENSOR 1580
FROM CONVENTIONAL PS 1330
D
S
LOW EFFICIENCY
1946
G
VOLTAGE SENSOR
1840
VOUT
1936
1345
1934
1840
1908
Vout
CONTROLLABLE REFERENCE VOLTAGE
1940
R2
CONTROLLABLE RESISTOR
I SENSE
A
1926
1942
1520
TO/FROM POWER BUS 1210
COMMUNICATION BUS
CONTROLLER
V-OUT SENSE
1750
T
TEMPERATURE SENSOR
1928

FIG. 25C

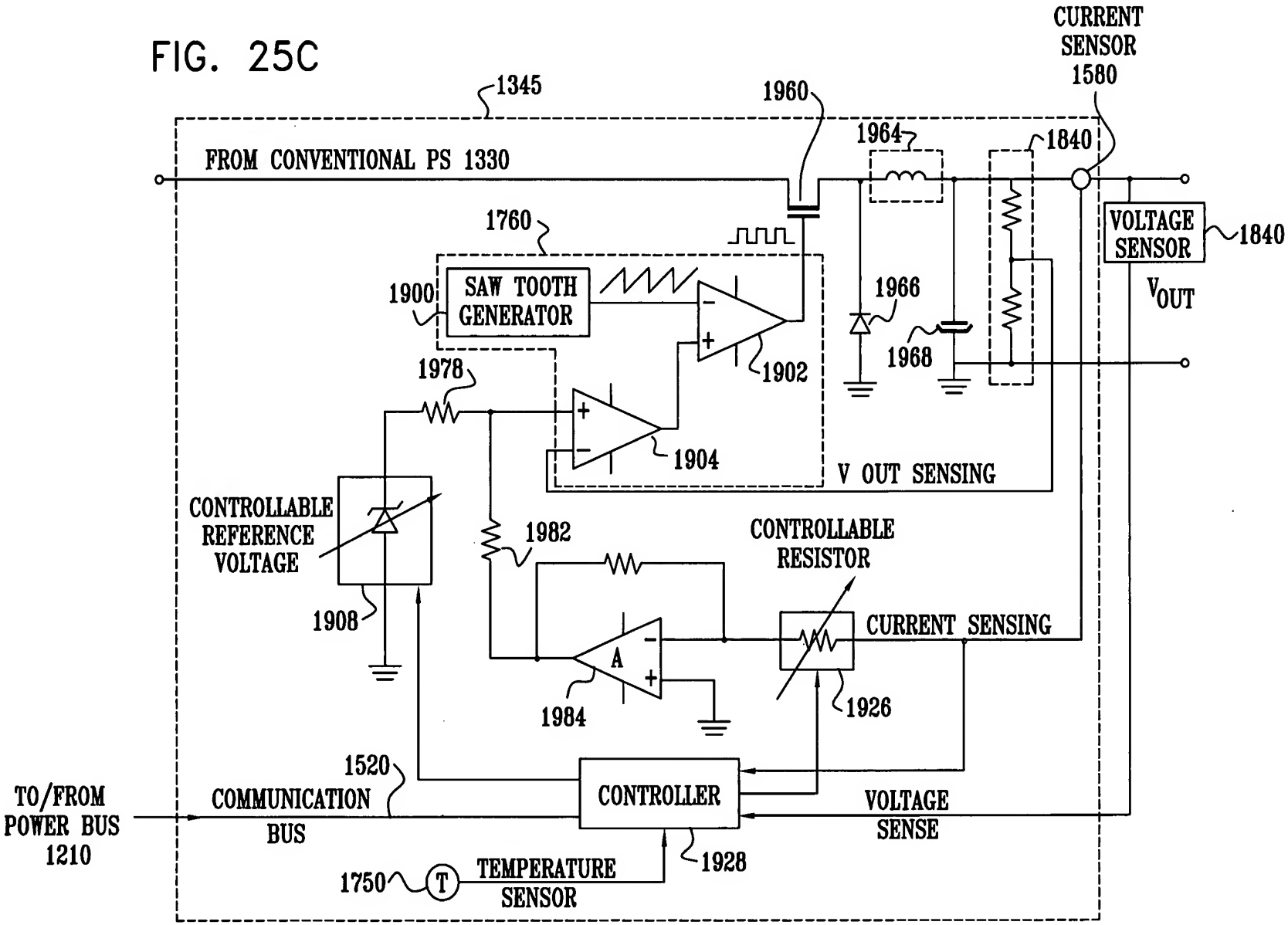

1345
1960
CURRENT SENSOR 1580
1964
1840
FROM CONVENTIONAL PS 1330
1760
VOLTAGE SENSOR
1840
$V_{OUT}$
1900
SAW TOOTH GENERATOR
1966
1902
1968
1978
1904
V OUT SENSING
CONTROLLABLE REFERENCE VOLTAGE
1982
CONTROLLABLE RESISTOR
1908
CURRENT SENSING
A
1984
1926
1520
TO/FROM POWER BUS 1210
COMMUNICATION BUS
CONTROLLER
VOLTAGE SENSE
1750
T
TEMPERATURE SENSOR
1928

FIG. 26A

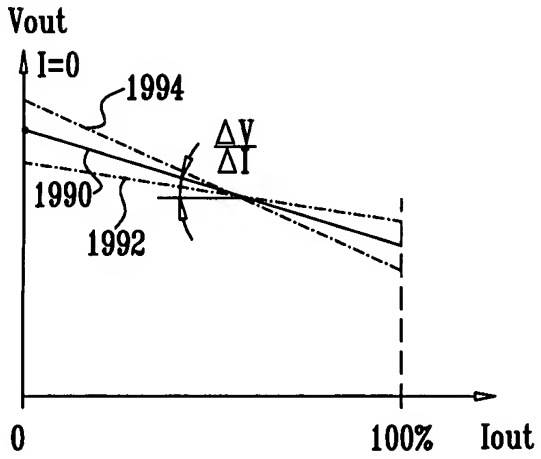



FIG. 26B

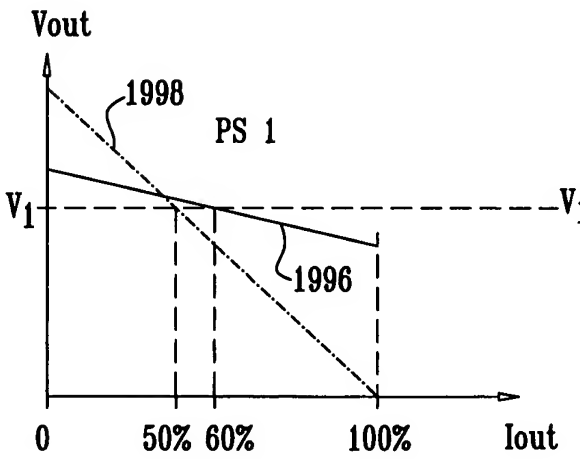



FIG. 26C

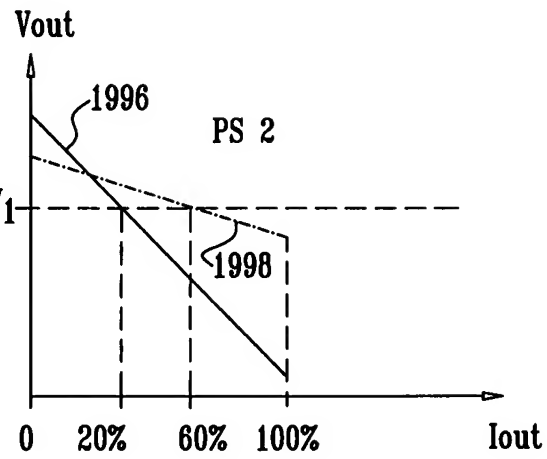


FIG. 27A

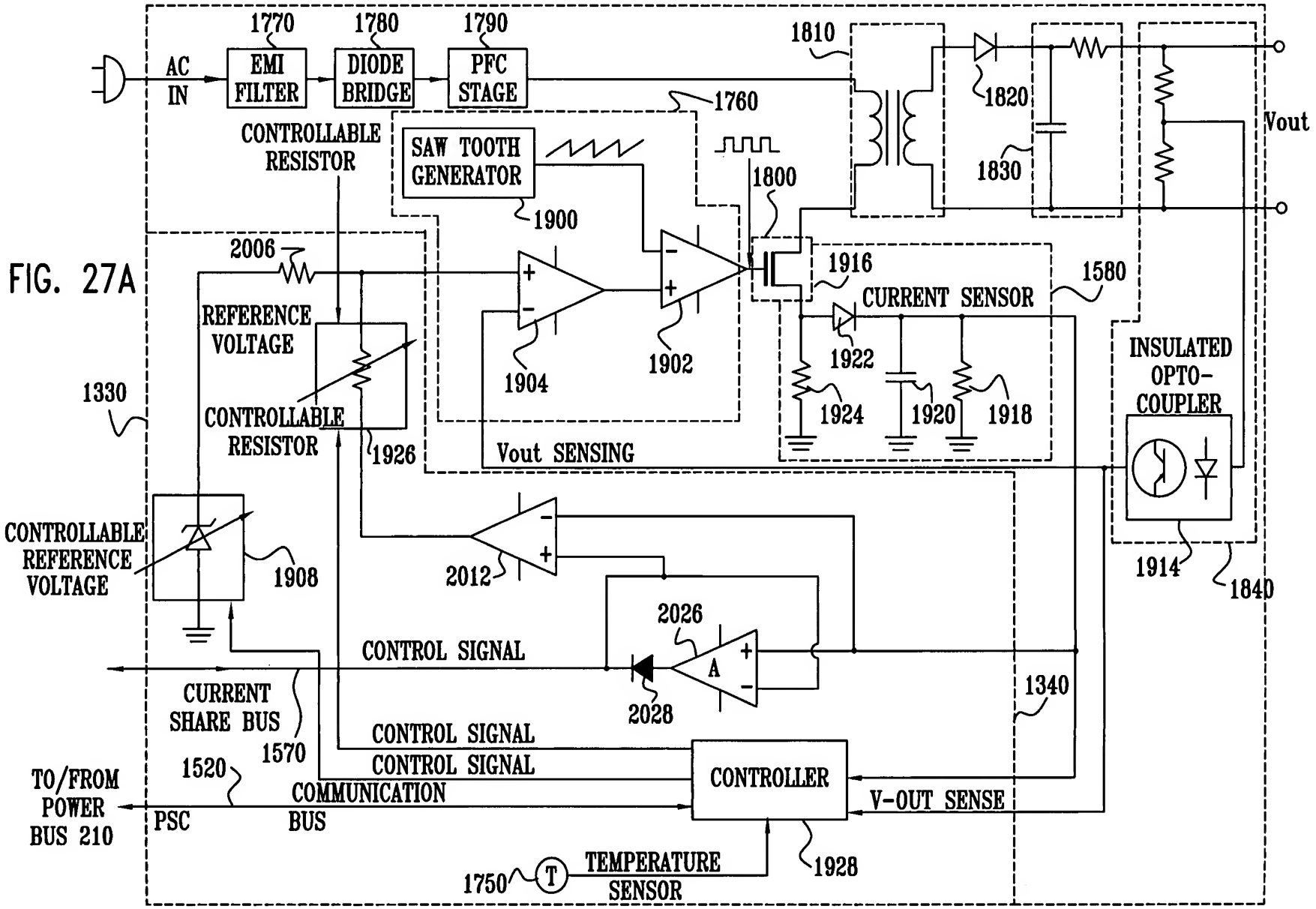

AC IN
EMI FILTER
1770
DIODE BRIDGE
1780
PFC STAGE
1790
1760
1810
1820
1830
Vout
CONTROLLABLE RESISTOR
SAW TOOTH GENERATOR
1900
1800
2006
1916
CURRENT SENSOR
1580
REFERENCE VOLTAGE
1904
1902
1922
1924
1920
1918
INSULATED OPTO-COUPLER
1330
CONTROLLABLE RESISTOR
1926
Vout SENSING
CONTROLLABLE REFERENCE VOLTAGE
1908
2012
1914
1840
2026
CONTROL SIGNAL
A
2028
1340
CURRENT SHARE BUS
1570
CONTROL SIGNAL
CONTROL SIGNAL
1520
TO/FROM POWER BUS 210
PSC
COMMUNICATION BUS
CONTROLLER
V-OUT SENSE
1750
T
TEMPERATURE SENSOR
1928

FIG. 27B

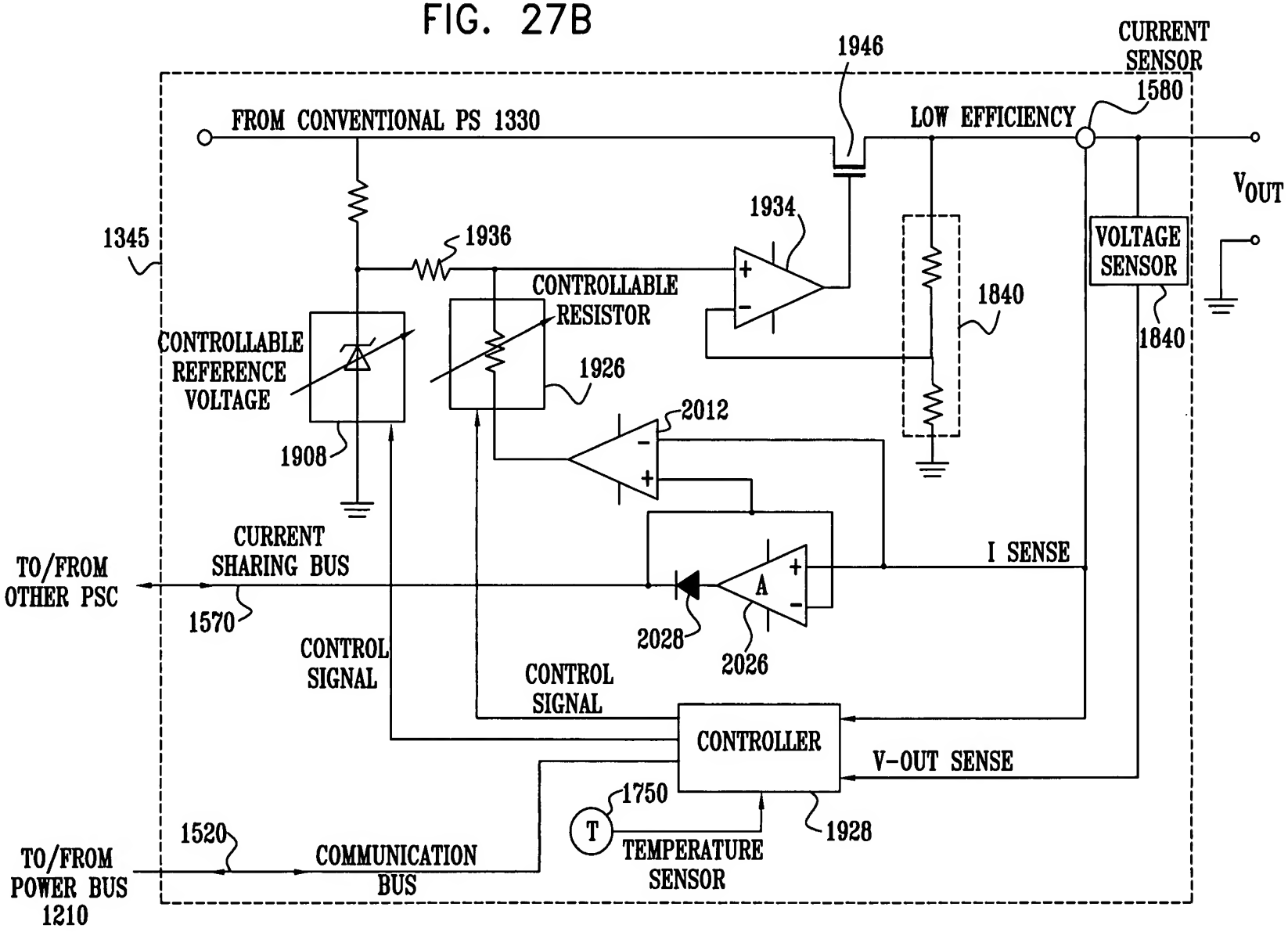

1946
CURRENT SENSOR
1580
FROM CONVENTIONAL PS 1330
LOW EFFICIENCY
$V_{OUT}$
1345
1936
1934
CONTROLLABLE RESISTOR
1840
VOLTAGE SENSOR
CONTROLLABLE REFERENCE VOLTAGE
1926
1840
2012
1908
CURRENT SHARING BUS
I SENSE
TO/FROM OTHER PSC
1570
2028
2026
CONTROL SIGNAL
CONTROL SIGNAL
CONTROLLER
V-OUT SENSE
1750
1520
1928
COMMUNICATION BUS
TEMPERATURE SENSOR
TO/FROM POWER BUS 1210

FIG. 27C

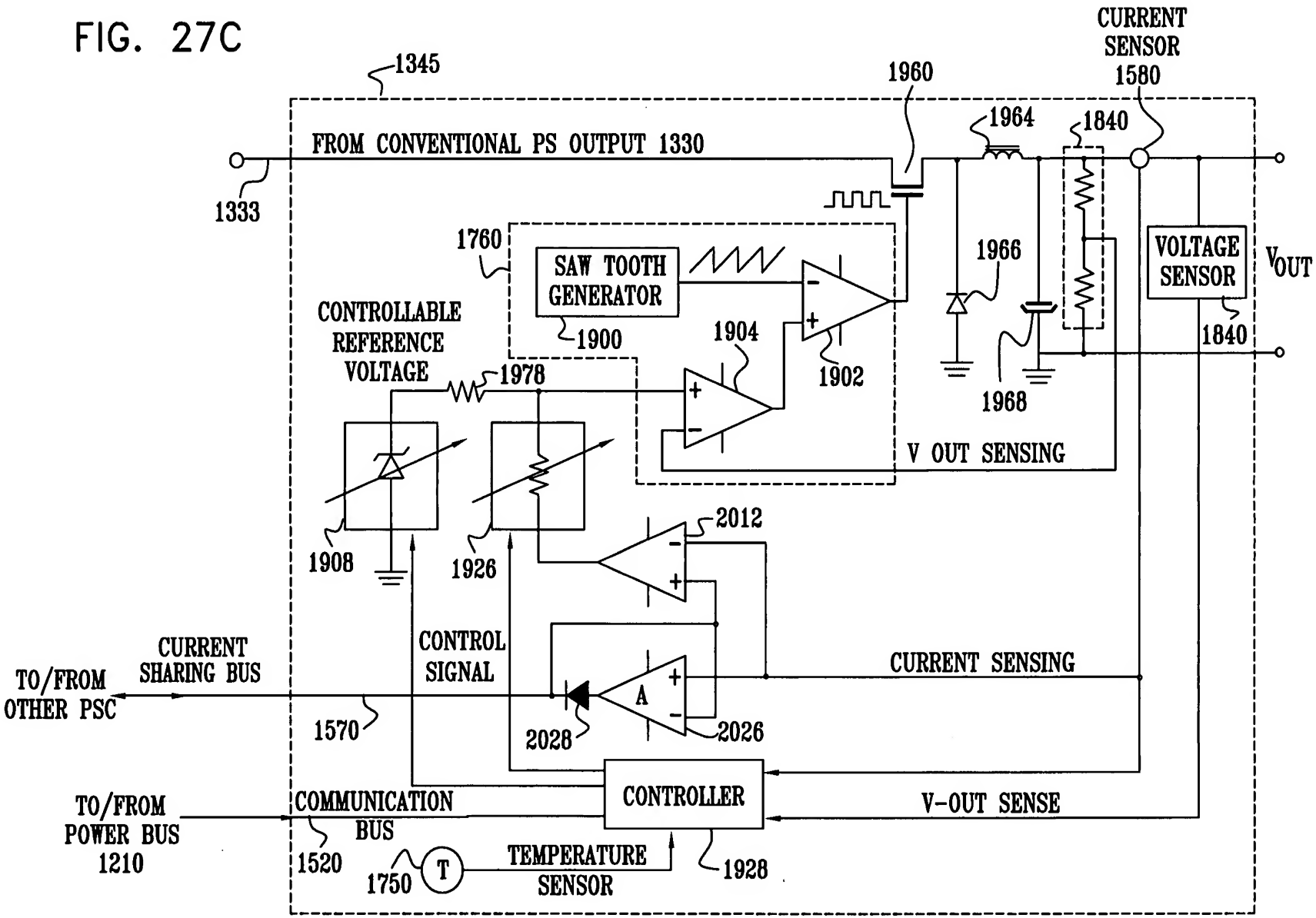

1345
1960
CURRENT SENSOR 1580
1964
1840
FROM CONVENTIONAL PS OUTPUT 1330
1333
1760
SAW TOOTH GENERATOR
1900
1904
1902
1966
VOLTAGE SENSOR
1840
$V_{OUT}$
CONTROLLABLE REFERENCE VOLTAGE
1978
1968
V OUT SENSING
2012
1908
1926
CONTROL SIGNAL
CURRENT SHARING BUS
TO/FROM OTHER PSC
CURRENT SENSING
A
1570
2028
2026
CONTROLLER
TO/FROM POWER BUS 1210
COMMUNICATION BUS
V-OUT SENSE
1520
1750
T
TEMPERATURE SENSOR
1928

FIG. 27D

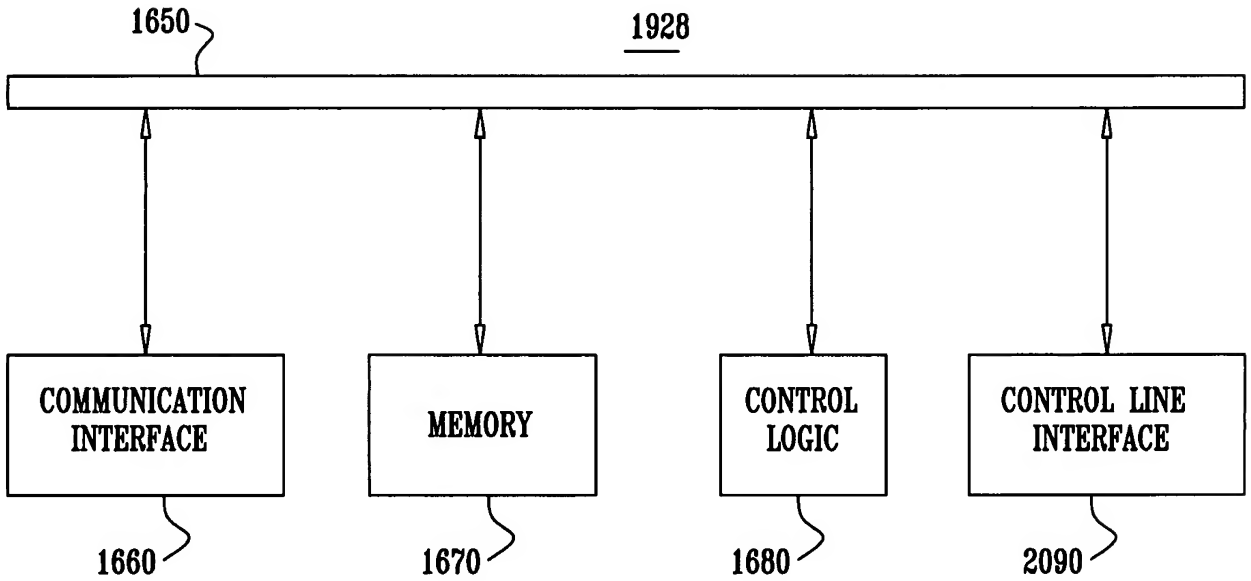

1650
1928
COMMUNICATION INTERFACE
MEMORY
CONTROL LOGIC
CONTROL LINE INTERFACE
1660
1670
1680
2090

FIG. 28A

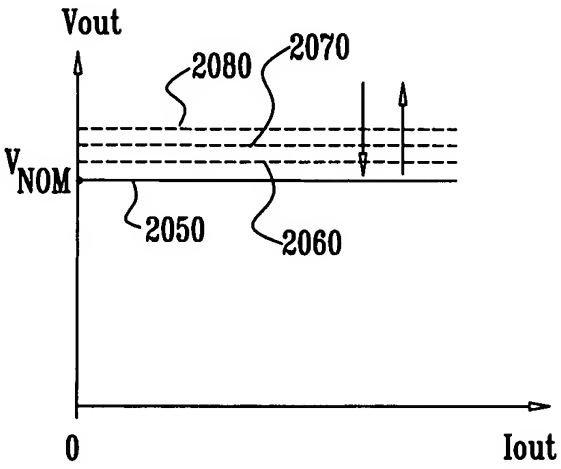



FIG. 28B

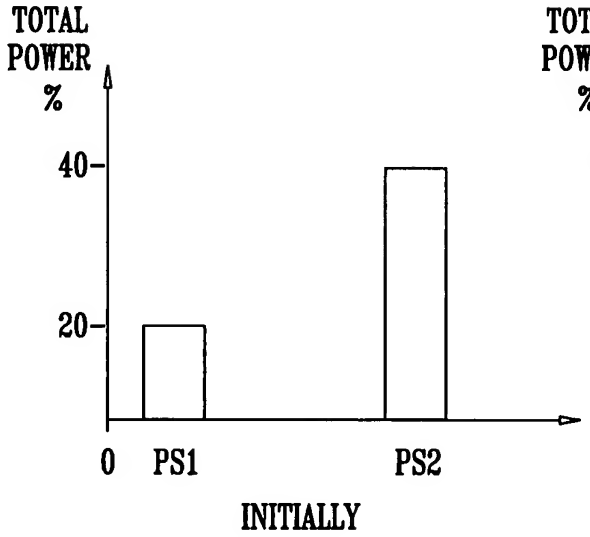



FIG. 28C

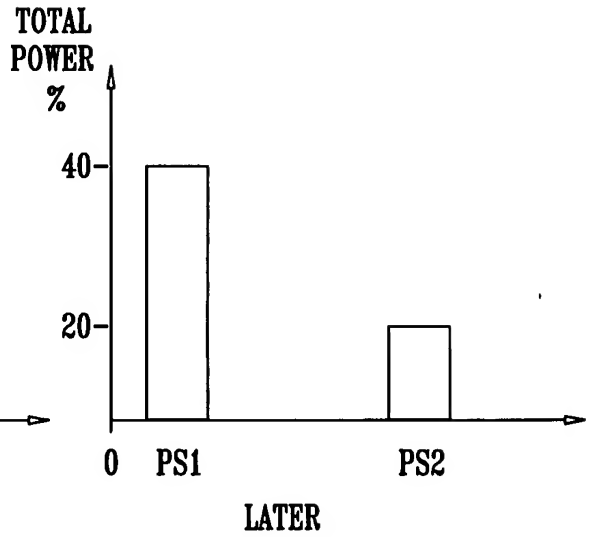


FIG. 29

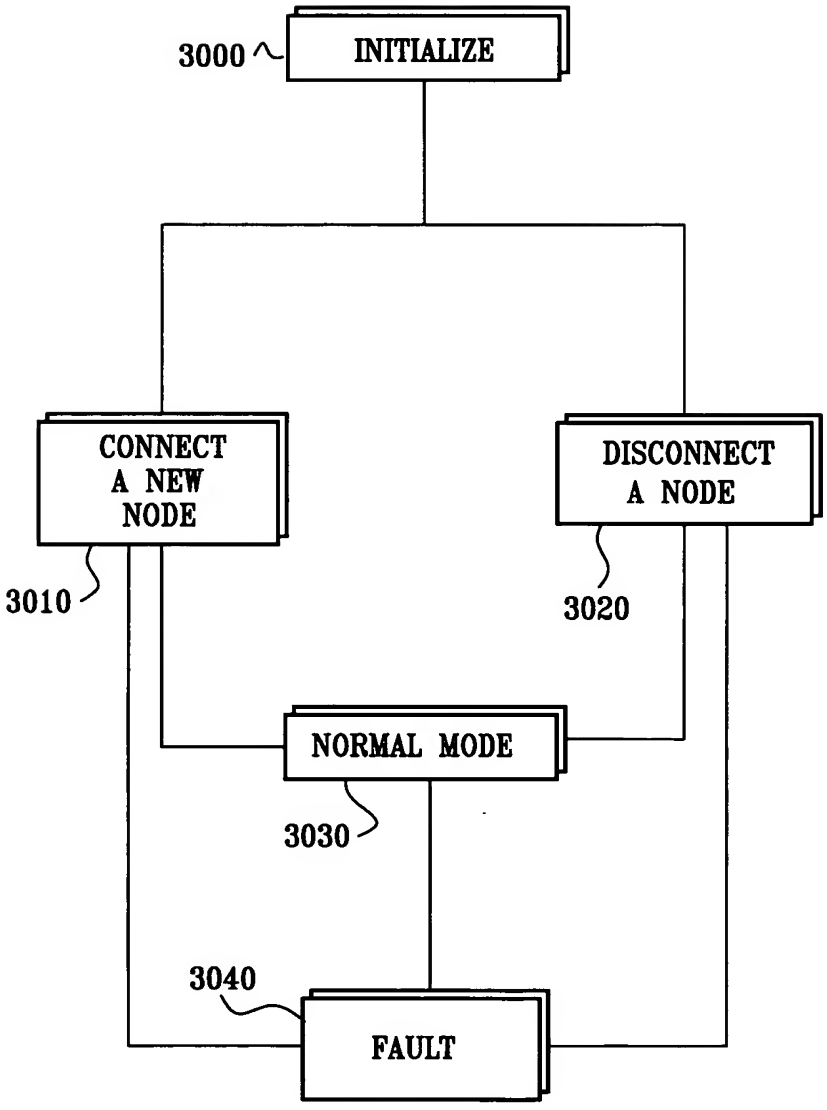

3000
INITIALIZE
CONNECT A NEW NODE
3010
DISCONNECT A NODE
3020
NORMAL MODE
3030
3040
FAULT

FIG. 30

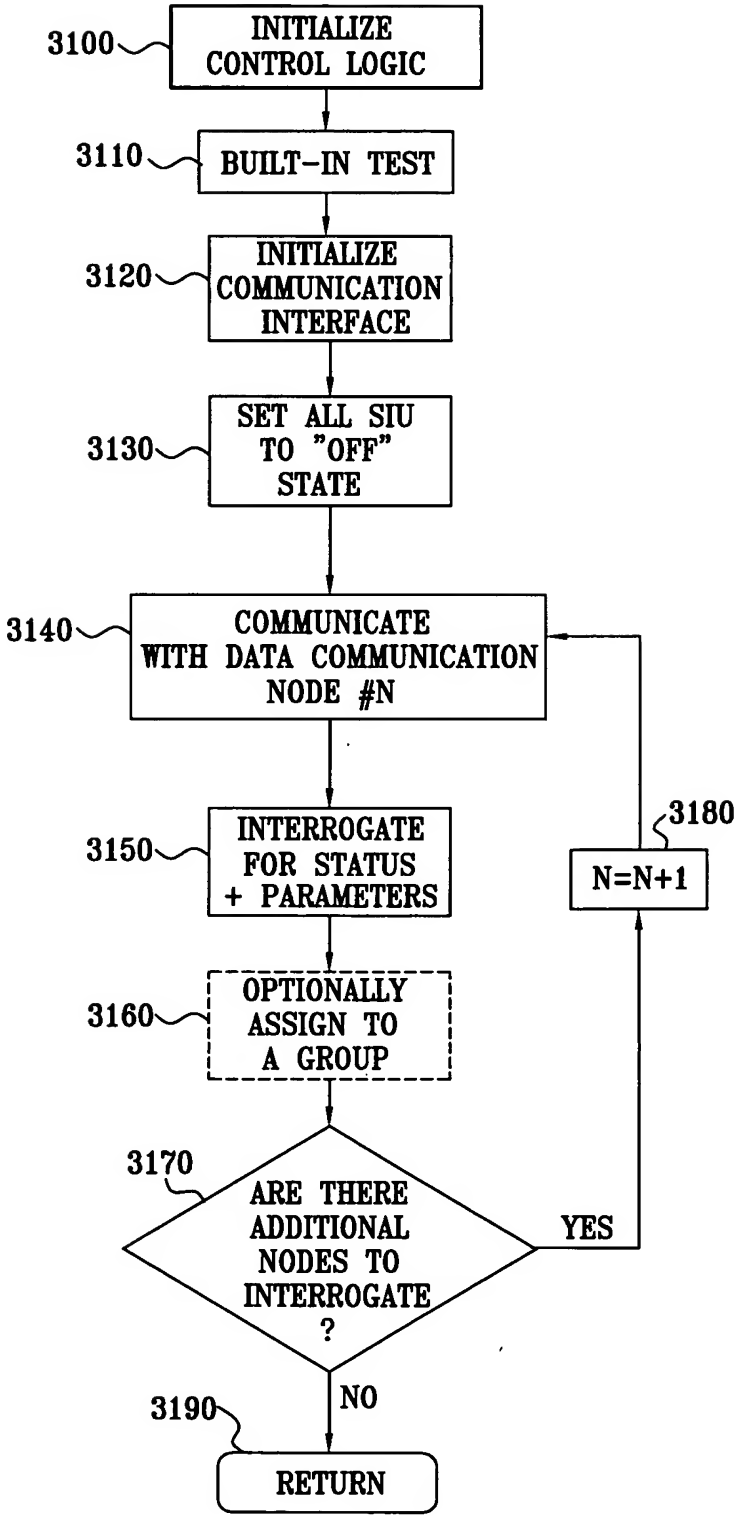

3100
INITIALIZE CONTROL LOGIC
3110
BUILT-IN TEST
3120
INITIALIZE COMMUNICATION INTERFACE
3130
SET ALL SIU TO "OFF" STATE
3140
COMMUNICATE WITH DATA COMMUNICATION NODE #N
3150
INTERROGATE FOR STATUS + PARAMETERS
3160
OPTIONALLY ASSIGN TO A GROUP
3170
ARE THERE ADDITIONAL NODES TO INTERROGATE ?
YES
NO
3180
N=N+1
3190
RETURN

FIG. 31

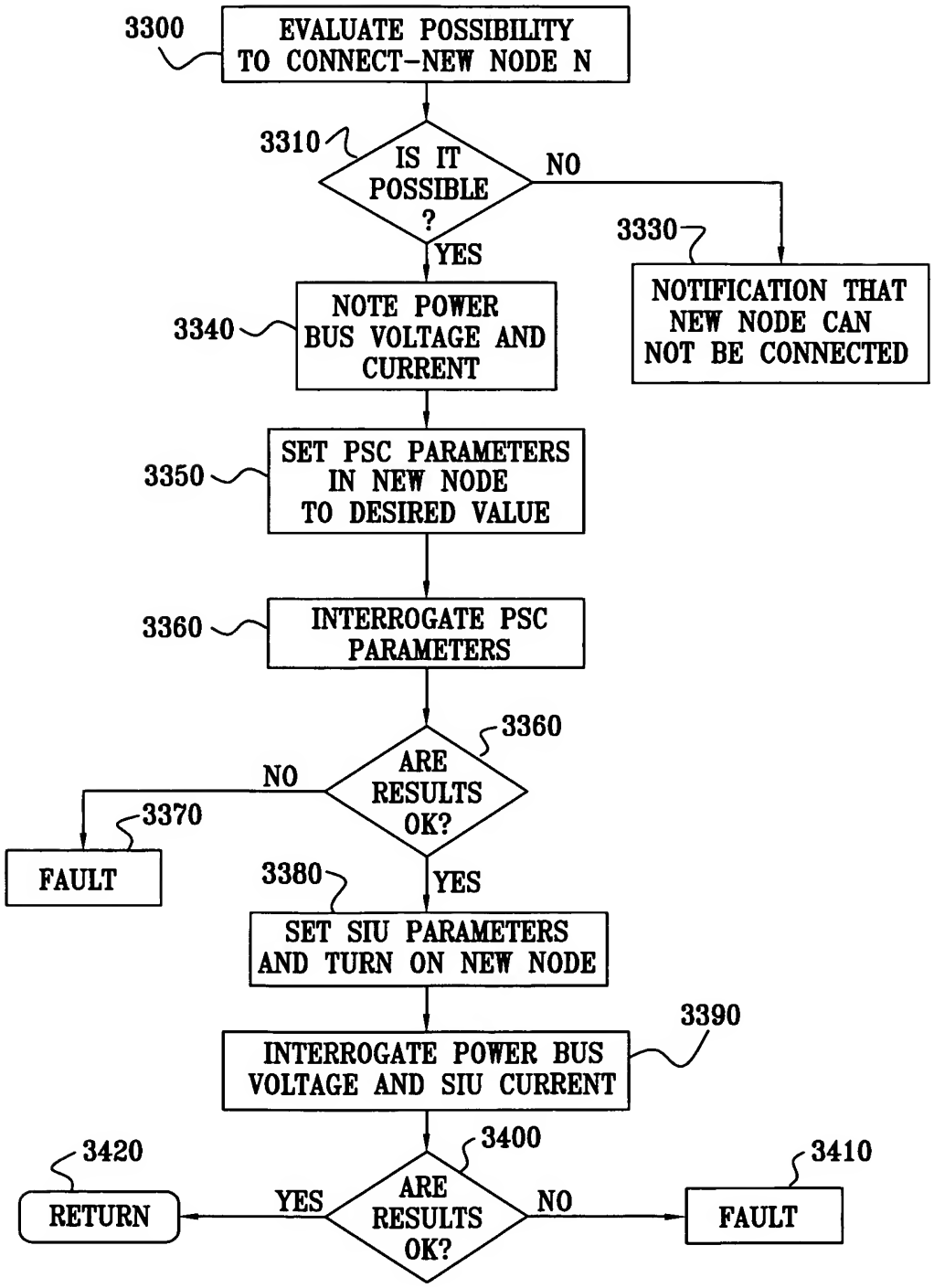

3300
EVALUATE POSSIBILITY TO CONNECT-NEW NODE N
3310
IS IT POSSIBLE ?
NO
YES
3330
NOTIFICATION THAT NEW NODE CAN NOT BE CONNECTED
3340
NOTE POWER BUS VOLTAGE AND CURRENT
3350
SET PSC PARAMETERS IN NEW NODE TO DESIRED VALUE
3360
INTERROGATE PSC PARAMETERS
3360
ARE RESULTS OK?
NO
3370
FAULT
3380
YES
SET SIU PARAMETERS AND TURN ON NEW NODE
3390
INTERROGATE POWER BUS VOLTAGE AND SIU CURRENT
3400
ARE RESULTS OK?
YES
3420
RETURN
NO
3410
FAULT

FIG. 32

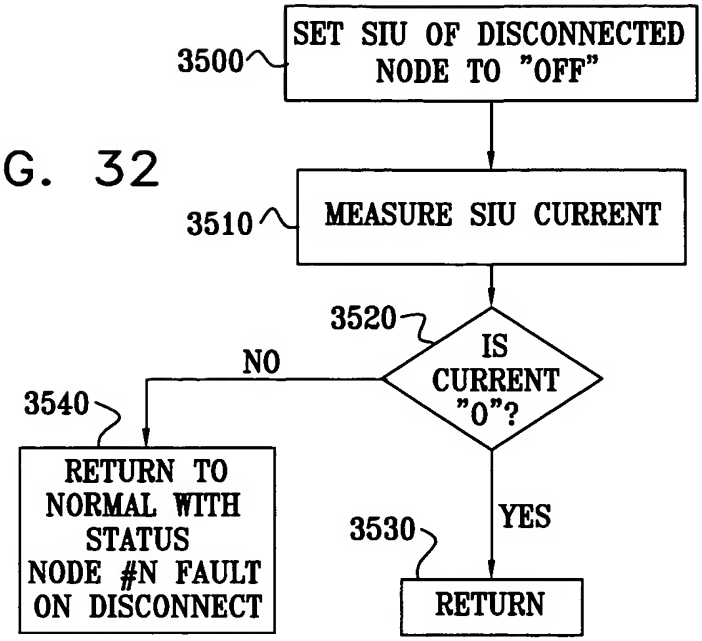

3500
SET SIU OF DISCONNECTED NODE TO "OFF"
3510
MEASURE SIU CURRENT
3520
IS CURRENT "0"?
NO
YES
3540
RETURN TO NORMAL WITH STATUS NODE #N FAULT ON DISCONNECT
3530
RETURN

FIG. 33

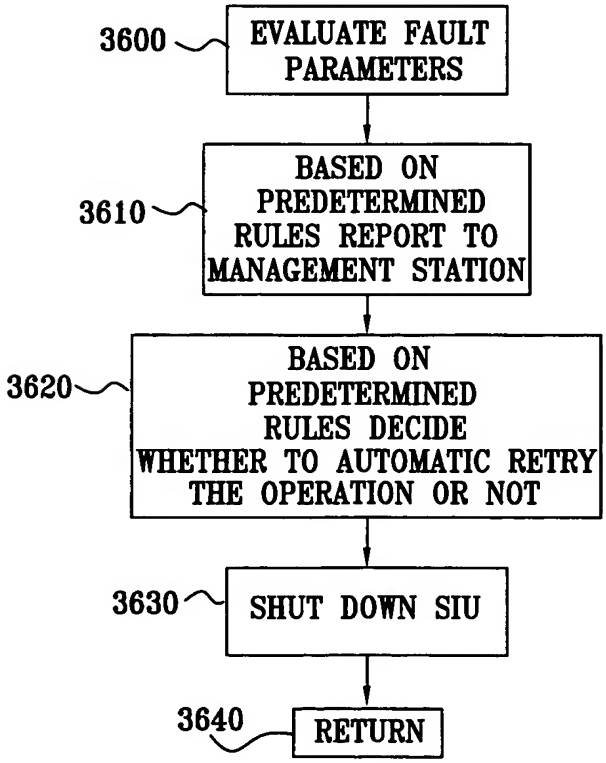

3600
EVALUATE FAULT PARAMETERS
3610
BASED ON PREDETERMINED RULES REPORT TO MANAGEMENT STATION
3620
BASED ON PREDETERMINED RULES DECIDE WHETHER TO AUTOMATIC RETRY THE OPERATION OR NOT
3630
SHUT DOWN SIU
3640
RETURN

FIG. 34

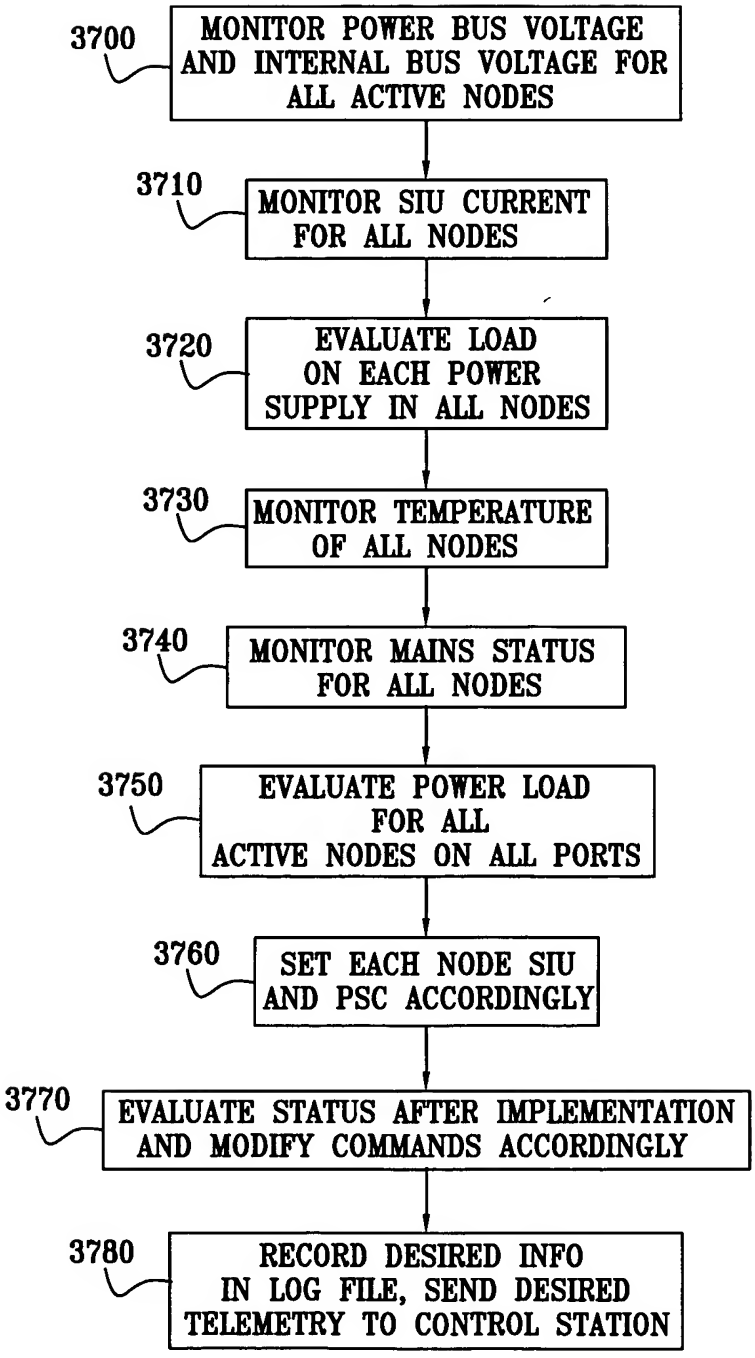
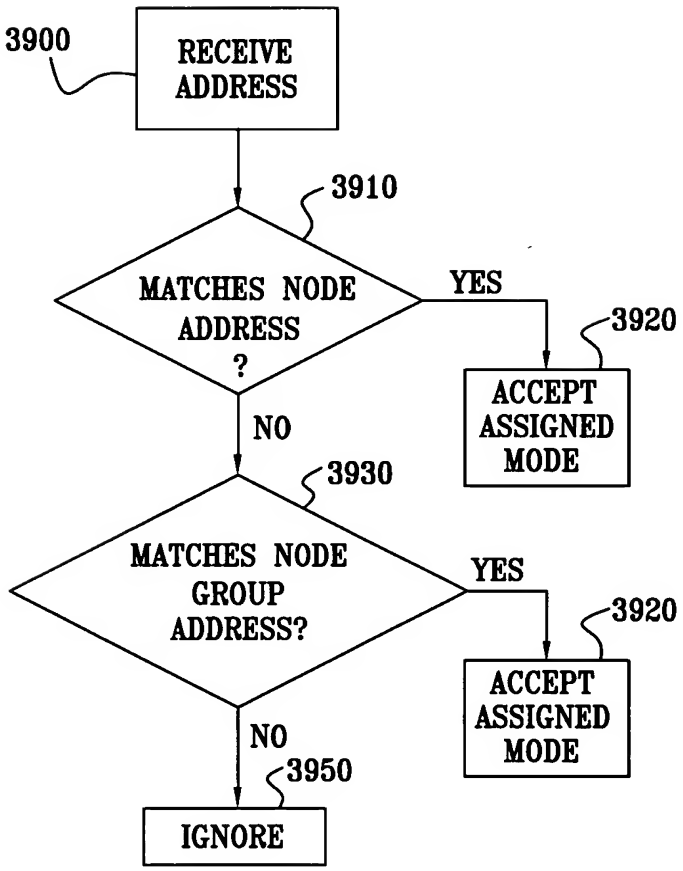

3700
MONITOR POWER BUS VOLTAGE AND INTERNAL BUS VOLTAGE FOR ALL ACTIVE NODES
3710
MONITOR SIU CURRENT FOR ALL NODES
3720
EVALUATE LOAD ON EACH POWER SUPPLY IN ALL NODES
3730
MONITOR TEMPERATURE OF ALL NODES
3740
MONITOR MAINS STATUS FOR ALL NODES
3750
EVALUATE POWER LOAD FOR ALL ACTIVE NODES ON ALL PORTS
3760
SET EACH NODE SIU AND PSC ACCORDINGLY
3770
EVALUATE STATUS AFTER IMPLEMENTATION AND MODIFY COMMANDS ACCORDINGLY
3780
RECORD DESIRED INFO IN LOG FILE, SEND DESIRED TELEMETRY TO CONTROL STATION

FIG. 35


3900
RECEIVE ADDRESS
3910
MATCHES NODE ADDRESS ?
YES
3920
ACCEPT ASSIGNED MODE
NO
3930
MATCHES NODE GROUP ADDRESS?
YES
3920
ACCEPT ASSIGNED MODE
NO
3950
IGNORE